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Automatic Prediction of Diabetics from Retinal Image using deep Convolutional Neural Network

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ABSTRACT: Automated retinal image analysis is becoming an imperative screening tool for early revealing of certain risks and diseases like Diabetic Retinopathy. Diabetic Retinopathy (DR) is the prominent cause of blindness in the world. Early detection of diabetic retinopathy can provide operative treatment. Earlytreatment can be conducted from detection of microaneurysms. Microaneurysms are the earliest clinical sign of diabetic retinopathy and they appear as small red spots on retinal fundus images. Microaneurysms are reddish in colour with a diameter less than 125 µm.

- The existing trained eye care specialists are not able to screen the growing number of diabetic patients. So there is a need to develop a technique that is capable to detect microaneurysms
- Early automated microaneurysms detection can help in reducing the incidence of blindness. In this project, we review and analyze the techniques, algorithms and methodologies used for the detection of microaneurysms from diabetic retinopathy retinal fundus images which is usually CT, MRI dataset images.

KEYWORDS:CNN, Arduino, Microcontroller ,Retinal image, Python

I. INTRODUCTION

Diabetes is a metabolic disease in which an individual has high blood glucose level, either because the body does not produce enough insulin, or because the cells are unable to effectively use the insulin that's produced. The high blood glucose in diabetes is related to damage of the small blood vessels of the retina, which results in diabetic retinopathy(DR). Diabetic retinopathy can cause the blood vessels within the retina to leak fluid or hemorrhage (bleed), which can lead to a blurred or impaired vision. In its later stages, new abnormal blood vessels proliferate on the surface of the retina, which may cause scarring and cell loss within the retina. Diabetic retinopathy is one of the common complications of diabetes. It's a severe and widely spread disease. The danger of the disease increases with age and thus, middle aged and older aged people with diabetics are vulnerable to Diabetic Retinopathy. People with DR whose eye sight is at risk can be treated with laser, to prevent visual impairment or blindness. But currently there is no treatment that can restore the vision that has already been lost. Detecting DR is a time consuming and manual process that requires a trained clinician to examine and evaluate digital color fundus photographs of the retina. Hence it is an important task to detect DR at an early stage.

II. EXISTING SYSEM

Diabetic retinopathy (DR) is a disease which causes blindness in people having diabetes. Currently, to detect DR, medical staff has to thoroughly examine images of the retina manually taken by the technique of Fundus photography. This is time consuming. In the existing approach, the diabetic analysis is performed manually which renders less accurate results. Also many research are proposed using Support Vector Machine (SVM) classifier in MATLAB software in which machine learning is not utilized efficiently. Unfortunately, there is no effective known cure for diabetic retinopathy and the present treatments available are just management strategies at best. So it's very important to detect the disease in its early stages.

III. PROPOSED SYSTEM

We proposed a model to detect DR using machine learning techniques such as Neural networks to make the detection process automated as well as accurate.

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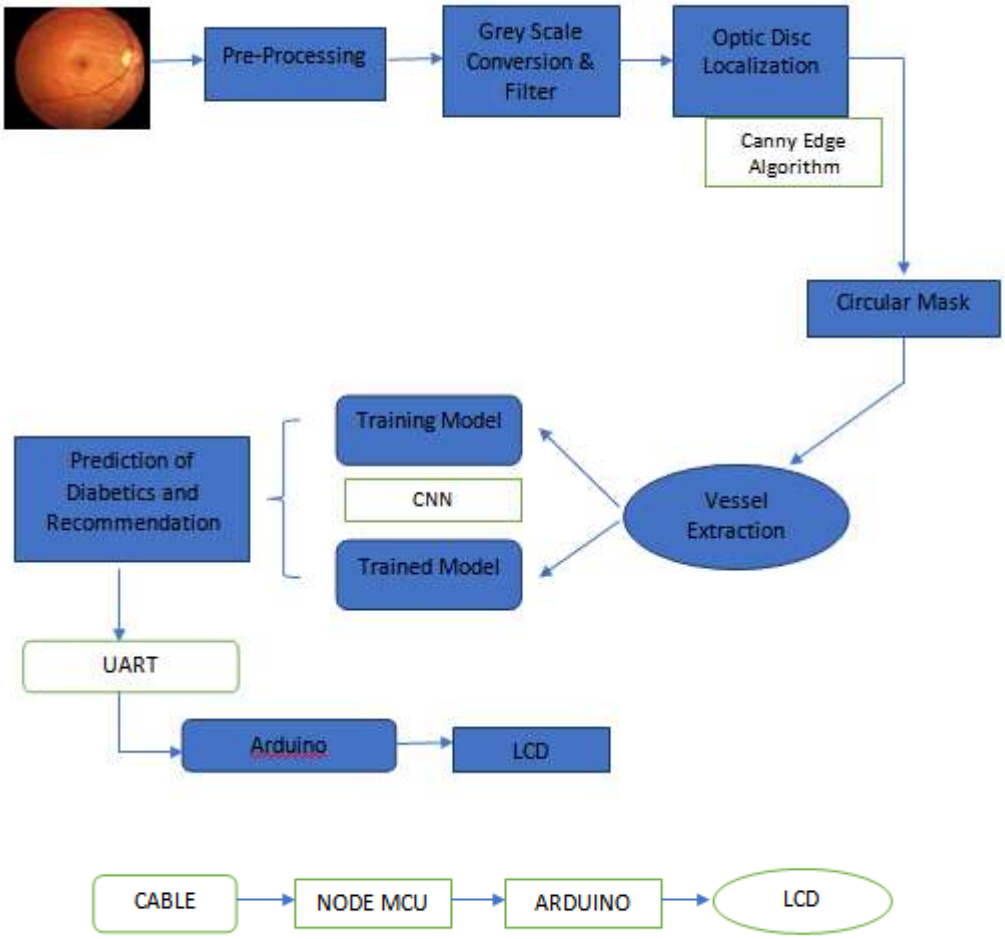
Machine learning consist of a number of stages to detect retinopathy in the fundus images that includes converting image to suitable input format, denoising and various preprocessing techniques. It also includes training a model with a training set and validating with a different testing set. Method proposed in this project can be listed in two steps: Image Preprocessing, and machine learning and Feature Extraction. First, the images are preprocessed. They are converted from RGB to grayscale. Proper resizing of image is also done. As the images are heterogeneous they compressed into a suitable size and format. Layer separation will also performed. For making intensity variations uniform histogram equalization to the image can be applied. Morphological operation will be done to remove the noise present in the background of retinal image. We then plan to use deep learning based Convolutional neural network (CNN) architecture for feature extraction and prediction of the class of DR. A CNN is able to capture the temporal and spatial dependencies in images and fits better due to the decrease in parameters used and weight reusability. It has the ability to train to understand the complexity of the image more efficiently. In this project to our knowledge first time we are thinking to integrate hardware with the software based image processing technique. The final outcome, prediction result would be transmitted to the hardware using UART and shown in the LCD.

IV. ARCHITECTURE DIAGRAM:



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V. MODULE DESCRIPTION

5.1 Data Pre-Processing:-

In this phase, the diabetes retinopathy image is taken for the detection. The input image in the RGB format which need to convert into the gray scale format. The gray scale image is further processed for the detection.

5.2 Optical Disk Segmentation:-

The OD is seen as a bright yellowish or white area within the colored fundus images. For the optic disc, high and similar intensity values are available for exudates. Thus, the removal of optic disc from the retinal image is very important. The region properties and area identification are used for masking and removing this brighter optic disc. The optic disc and blood vessels are detected by applying edge detection algorithm after preprocessing. The counter detection is performed using **canny edge detection algorithm**. All the local maxima known as the gradient is preserved for improving the blurred edges by the canny edge detection algorithm.

5.3 Blood Vessal Extraction:-

This is due to the fact that their concentration levels are similar. The high levels of contrasts vessels present in the blood are removed by applying dilation on the intensity image. Further, the dilation operation is used to fill the small holes present within the images along with the help of structuring element. There are different shapes in which structure elements (SE) exist. The optical disc and blood vessels are removed here using the flat disc shaped structure.

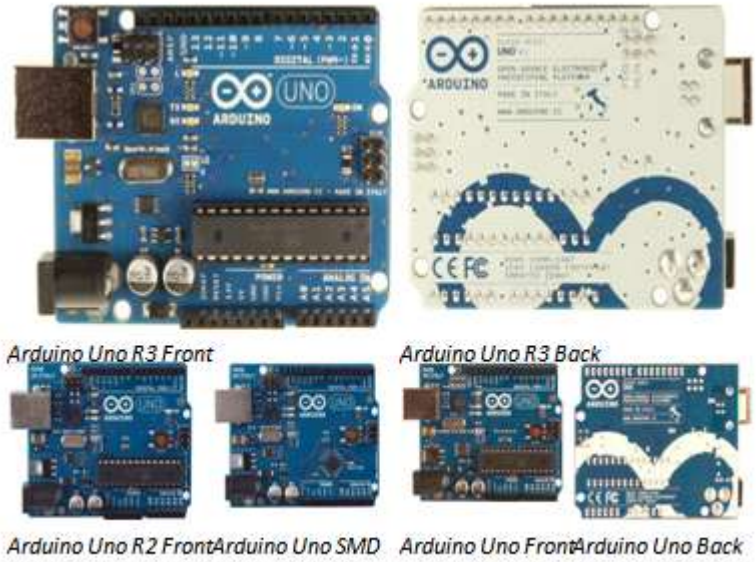
5.4 Classification:-

The last phase is of classification which is applied with the **CNN (Convolutional Neural networks)**. The CNN approach is the unsupervised approach for the diabetes retinopathy detection. The training set is prepared based on the color features of the input image. The system can train itself until error gets minimized in the network. The stage at which error gets minimized at that stage system is considered as maximum trained. The test image is taken as input for the diabetes retinopathy detection.

5.5 Hardware Interface:

In the hardware interface, the outcome from the software console that is google colab we shall be transmitting the hardware interface using UART package. From the UART, we shall obtain the outcome and display in the hardware. Thus this can be enhanced to further hardware enhancements.

5.5.1 ARDUINO MICROCONTROLLER:



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Summary

Microcontroller	ATmega328
Operating Voltage	5V

Input Voltage (recommended) 7-12V

Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

5.5.2NODE MCU:

NodeMCU is an open-source Lua based firmware and **development board** specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

The **NodeMCU ESP8266 development board** comes with the ESP-12E module containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

NodeMCU can be powered using Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

5.5.3 LCD 16X2

This is an LCD Display designed for E-blocks. It is a 16 character, 2-line alphanumeric LCD display connected to a single 9-way D-type connector. This allows the device to be connected to most E-Block I/O ports.The LCD display requires data in a serial format.

5.6 SOFTWARE ENVIRONMENT:

The Jupyter Notebook combines three components:

- **The notebook web application**: An interactive web application for writing and running code interactively and authoring notebook documents.
- **Kernels**: Separate processes started by the notebook web application that runs users' code in a given language and returns output back to the notebook web application. The kernel also handles things like computations for interactive widgets, tab completion and introspection.
- **Notebook documents**: Self-contained documents that contain a representation of all content visible in the notebook web application, including inputs and outputs of the computations, narrative text, equations, images, and rich media representations of objects. Each notebook document has its own kernel.
- **ANACONDA**
- **Anaconda** is a distribution of the Python and R programming languages for scientific computing (data science, machine

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learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. The distribution includes data-science packages suitable for Windows, Linux, and macOS. It is developed and maintained by Anaconda, Inc., which was founded by Peter Wang and Travis Oliphant in 2012.

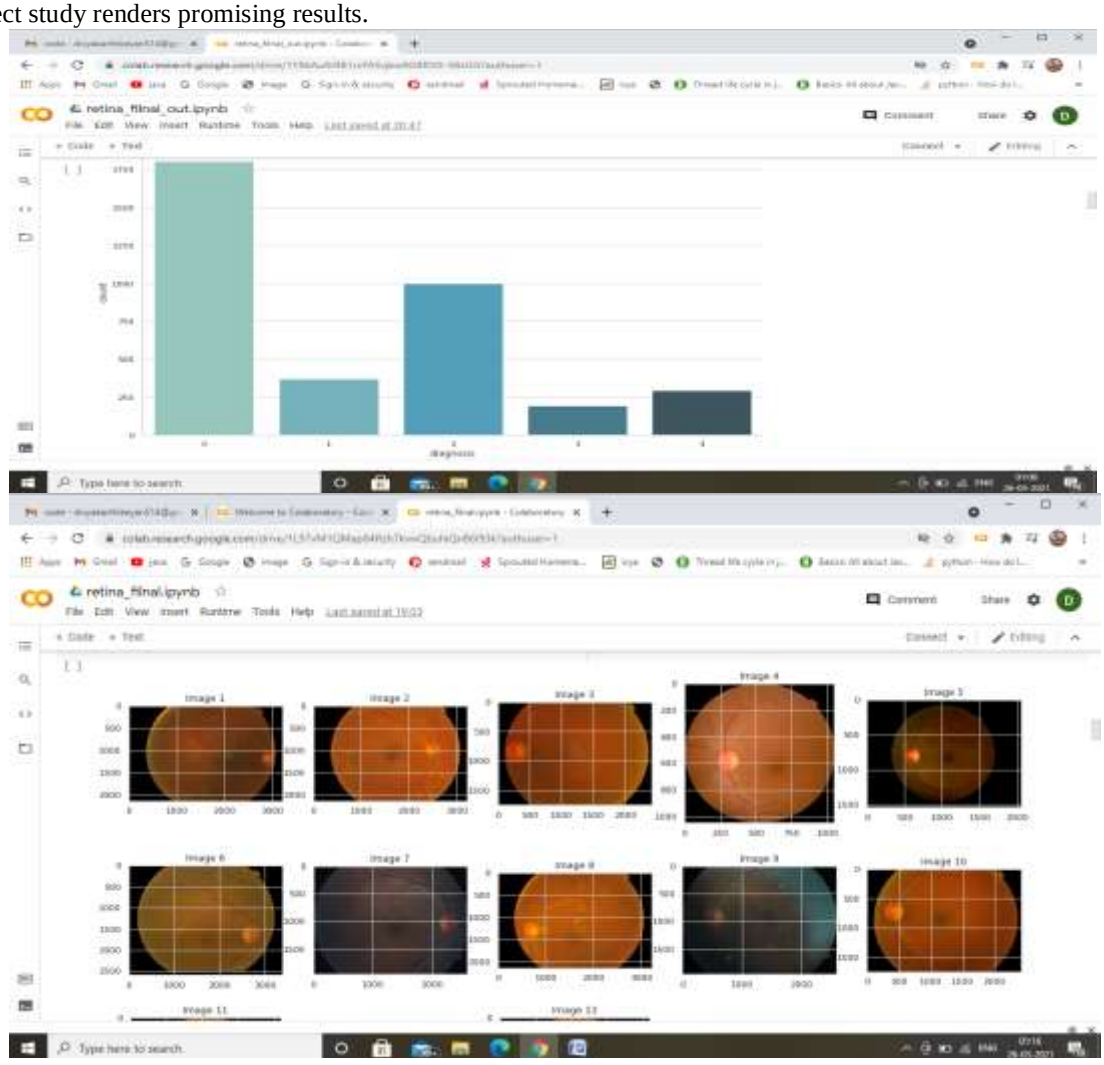
VI. CONCLUSION

This project study accepts the retinal fundus image as the input to detect diabetic retinopathy. This project experimental results are carried in google colab. The computer vision and machine learning techniques are applied on the input image to predict normal, diabetic stage and recommend accurate medicinal measures. Thus the project study renders promising results.

VII. FUTURE WORK:

The project is constantly evolving. Implementing novel techniques, we expect to further increase the accuracy of the method as well as to expand it to other eye diseases. Here is an abbreviated list of steps we take to achieve our objectives:

- Larger data sets for model development
- Image quality assessment module
- Experiments with other deep learning architectures
- Development of a neural model based on detection principles and capable of exact discovery of subtle lesions (Drusen, Exudates, Microaneurysms, Hemorrhages, and Cotton-wool Spots) just like retinal specialists do
- Expansion to cataract and glaucoma diagnostics



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