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RETINAL DISEASES PREDICTION IN IMAGE PROCESSING

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ABSTRACT

"**CLEAR VISION GIVES YOU A CLEAR LIFE**", this wording means a lot. Each and every person wish to have a good vision to survive, enjoy and for committing a peaceful life and most of the people do get the same. A promising good vision is presented by a good retina and its retinal health. As a coin have two sides there is also some diseases which affect the retinal layer in our eyes. A healthy retina is essential for clear vision. Retinal diseases are common as they can affect any part of the eye. As retinal diseases affect the vital eye tissue, it causes serious problems, affects vision, some even leading to blindness. Ones if people affect with the retinal disease they come to know after a severe affect in vision. The sad part is that we don't even get any pain or wound when we get retinal disease, we can't predict the symptoms easily. After getting the decrease in vision rate common people will approach the eye hospitals and consult an ophthalmologist. They usually went through a screening test handling with CAD machines, which means Computer Aided Diagnosis technique connected with the computer and to the internet connection. which is a complete Artificial Intelligent machine. which will be costlier and common people don't get a better guideline to approach at the beginning stage. To overcome this issue, we have planned to develop an early predictor of pre-clinical signs of retinal disease symptoms by involving Image Processing technique. Now we are planning to create a prototype of an "Early predictor of retinal diseases by image processing" and to implement it as working model of vending concept and to keep in public places and allow common people to utilise it with less cost and with minimum handling. We have analysed so many algorithms to implement our idea, finally we are satisfied with HAAR Cascade Algorithm Which is a Machine Learning Technique, because One of the primary benefits of HAAR cascades is that they are just so fast — it's hard to beat their speed. HAAR algorithm does not undergone dual segmentation process for further classification where as other image processing algorithm will lies under with segmentation and without segmentation processing and it will consume more time. Some other ML algorithms will demand fundus image for image processing later in it will convert the colour image to grayscale image using scanner, but HAAR Algorithm does not demand it for all this reasons we have chosen HAAR Algorithm and it is also satisfying our needs to the extend. We are using OPENCV which is open-source computer vision for implementing the programming which will be developed in python language. We have chosen OPENCV it is platform independent

and it already have predefined library files for image processing which will reduce our working space. We are using Raspberry PI as a SOC, it will swap the work of a main frame computer because it is low cost, huge processing power in a compact board and have many interfaces. We are using PI Camera for image capture resolution with 1080p at 30 frames. PI Camera has a better graphic processing capability than others.

Introduction

Most people have eye problems at one time or another. Some are minor and will go away on their own, or are easy to treat at home. Other's need a specialist's care. There are several common and rare eye conditions which affect vision. A healthy retina is essential for clear vision. Retinal diseases are common as they can affect any part of the eye. As retinal diseases affect the vital eye tissue, it causes serious problems, affects vision, some even leading to blindness. For eye diseases, one might miss marking any symptoms, since they are not easily detected or may be painless. Avoidable conditions, which can be influenced by socioeconomic factors such as low education and poverty, account for the majority of blindness in the elderly population worldwide. With increased life expectancy in different countries, a widespread age-related eye disease is expected in the future unless appropriate modifications are made in both eye care delivery systems and lifestyles.

Most of the principal causes of vision impairment includes cataract, glaucoma, Diabetic Retinopathy, refractive errors, Age-related macular degeneration. One of the best ways to protect your vision is through professional eye examinations, but these conventional diagnostic tests are tremendously dependent on physician's professional experience and knowledge, which lead to high misdiagnosis rate and huge waste of medical data. For this reason, scientists and doctors started developing Artificial Intelligence (AI) machines which perform an online eye test and based on an algorithm it makes a prediction for the vision result. As the test goes on, the algorithm is able to make a more accurate prediction about the result. Hence, these AI techniques have potential to perform eye examinations much better than human beings and they stand as an effective diagnostic tool to identify various eye diseases. Applications of AI in the field of ophthalmology can make great contribution to provide support to patients in remote areas by sharing expert knowledge and limited resources.

The main objective of our project is to predict the preclinical signs or symptoms of most alarming retinal diseases like diabetic retinopathy, glaucoma, strabismus and eye floaters. We are aiming to create a prototyping for classifying these retinal diseases and making it for common people use. Our plan is to implement this project in a vending machine concept with coin dispenser. This concept will help common people to check the symptoms of retinal disease with less amount without approaching hospitals. Analyse the relation between different symptoms of retinal diseases such As Diabetic Retinopathy, Glaucoma, Stribismus and Eye Floaters. Classify the data using Image Processing Technique Through HAAR Algorithm in Machine Learning by means of Python software. Calculate the accuracy of algorithm and deducing the most appropriate algorithm for the diagnosis. Solving the problem by developing python programming for HAAR algorithm and implementing by the open CV platform.

Keywords

HAAR, open CV, Laplacian of Gaussian, CNN, Computer Aided Diagnosis

Related Work

Doaa K. Elswah, Ahmed A. Elnakib and Hossam El-din Moustafa et al, presented an Automated Diabetic Retinopathy Grading using ResNet. It presents a deep learning framework for the classification of diabetic retinopathy (DR) grades from fundus images, composed of three different stages. First, the fundus image is preprocessed using intensity normalization and augmentation. Second, the preprocessed image is given as input to ResNet Convolution Neural Network (CNN) in order to obtain the extraction of the feature. Finally, a classification step is performed to detect the DR. The overall classification accuracy using ResNet is 86.67%

AhsanHabib Raj, Al Mamun and FarukuzzamanFaruket al, presented a CNN Based Diabetic Retinopathy Status Prediction using Fundus Images. A computational model for Predicting Diabetic Retinopathy (DR) status which is based on retinal images and neural networks was designed. This model has been consisting of the feature extraction phase and classification phase. In feature extraction, the most appropriate features from digital fundus images by blood vessels and micro aneurysms was extracted. For the classification purpose CNN (VGG) was used. This proposed model had an accuracy of 95.41%.

Meher Madhu Dharmana and Aiswariya M S et al, presented a Pre-diagnosis of Diabetic Retinopathy using Blob Detection. An effective feature extraction technique based on blob detection followed by different stages of diabetic retinopathy using machine learning technique was done. The feature extraction technique used here is Laplacian of Gaussian (LOC), this could help automatic characterization of retina images for diabetic retinopathy. The accuracy obtained in this model is 83%, which would help specialists to handily recognize the patient's condition in a progressively precise manner.

NihelZaaboub and Ali Douik et al, presented an Early diagnosis of Diabetic Retinopathy using Random Forest Algorithm. A hard exudate detection algorithm is proposed. Automatic detection of the hard exudates in colour fundus retinal image is an important task to early diagnosis of diabetic retinopathy. It is based on the application of a learning method of retinal image with removed optic disc. This paper proposed the use of a Random Forest algorithm with a specific parameter from which a binary mask of exudate is obtained after intensity threshold. This model obtained the accuracy of 94.38%.

Harry Pratt, FransCoenen, Deborah M Broadbent, YalinZheng et al, presented a Convolutional Neural Network for Diabetic Retinopathy. A proposed CNN approach for diagnosing DR from digital fundus images and accurately classifying its severity had been created. A network with CNN architecture and data augmentation which can identify the intricate features involved in the classification task such as micro-aneurysms, exudate and haemorrhages on the retina and consequently provide a diagnosis automatically and without user input. The accuracy obtained in this model is 75%.

ArkajaSaxena, AbhilashaVyas, LokeshParashar and UpendraSingh et al, presented A Glaucoma Detection using Convolutional Neural Network. It presents the architecture for the proper glaucoma detection based on deep learning by making use of the Convolutional Neural Network (CNN). The differentiation between the patterns formed for glaucoma and non-glaucoma can be found with the use of the CNN. The CNN provides a hierarchical structure of the images for differentiation. Here the dropout mechanism is used for achieving the adequate performance in the glaucoma detection. This analysis is performed using datasets and the obtained accuracy is 80%.

Mamta Juneja, Shaswat Singh, Naman Agarwal, Shivank Bali, shubham Gupta, Niharika Thakur and Prashantjindal et al, presented an Automated Detection of Glaucoma using deep learning Convolutional network(G-net). A proposed Convolutional Neural Network (CNN) was created as they can infer hierarchical information from the image which helps them to distinguish between glaucomic and non-glaucomic image patterns for diagnostic decision. This paper is based on the Artificially Intelligent glaucoma expert system based on segmentation of optic disc and optic cup. A deep learning architecture is developed with CNN working at its core for automating the detection of glaucoma. The proposed system uses two neural networks working in conjunction to segment optic disc and cup. This proposed model obtained an accuracy of 95.8% for disc and 93% for cup.

K. Navya, K. Lekhna and S. PraylaShyry et al, presented Early-Stage Detection of Glaucoma and its levels using fundus images of eye. An ideal framework is proposed which aims at developing a smart solution that helps in identification of glaucoma using MATLAB software tools. The preprocessing of the fundus image takes place followed by the segmentation and the classification. The preprocessing module takes place with the help of Gaussian filtering and guided image filters for removing the noise. Classification of healthy and diseased eyes is done with the help of the K-Nearest Neighbour (KNN) algorithm. The accuracy of this model is 88%.

Afolabi O. Joshua, Fulufhelo V. Nelwamondo, Gugulethu Mabuza Hocquet et al, presented a Segmentation of Optic Cup and Disk for Diagnosis of Glaucoma and Retinal Fundus Images. The estimation of optic cup and disk ratio (CDR) is a valuable tool for identifying the glaucoma. The CDR can be obtained only by segmenting the optic cup and optic disk from the fundus images. In this work improved U-net Convolutional Neural Network architecture was used to segment the optic disk and optic cup from the fundus images. The dataset was taken from RIM-ONE which gave an accuracy of 82% for optic cup and 95% for optic disk.

Krati Gupta, Anshul Thakur, Michael Gold baum, and Siamak Yousefi et al, presented a Glaucoma Precognition: Recognizing Preclinical Visual Functional Signs of Glaucoma. The purpose of this study is to develop a precognition framework to identify preclinical signs of glaucomatous vision loss using convex representations. They have developed an AA structure and a novel Deep Archetypal Analysis (DAA) framework to recognize hidden patterns of visual functional loss, and then project visual field data over the identified patterns to obtain the representation for glaucoma precognition several years prior to disease onset. It has been noticed that their proposed glaucoma precognition approach could significantly advance the state-of-the-art glaucoma prediction. The accuracy value obtained is 71%

Existing System

AI assisted automated screening and diagnosis of the common disease in ophthalmology are helping to maximize the doctor's role at the clinic. This increased usage of AI in medicine not only helped in reduction of manual tasks, increasing efficiency and productivity, but it also presents the opportunity for us to move towards more precision medicine and offer the patients more medical openings that reduces the obstacles for them to access for an eye care where an ophthalmologist is not available.

Computer Aided Diagnosis (CAD)

The existing Computer Aided Diagnosis (CAD) is a piece of software programmed using Artificial Intelligence (AI) techniques. Such CAD systems make use of expert knowledge to offer advice or make decisions in areas like medical diagnosis. With the CAD, the user can interact with the computer to solve a certain problem.

Fan huang have proposed a stability analysis of fractal dimension in retinal vasculature in this, Fractal measurement (FD) has been considered as a potential biomarker for retina-based malady recognition. Early acknowledgment and helpful treatment have been seemed to balance visual hardship and visual inadequacy in patients with retinal complexities of diabetes. The execution of any count can be differentiated just and the human scrutinizes, in light of the way that access to the certifiable state of sickness in the dataset isn't available. DR acknowledgment figuring's achieve equivalent execution to a lone retinal ace for every client and are close create, and further quantifiable updates in area execution are implausible.

Erik J. Bekkers have proposed a Curvature Based Biomarkers for Diabetic Retinopathy via Exponential Curve Fits in SE (2) which is used to identify Microaneurysms parts. The recognizable proof of microaneurysms in cutting edge shading fundus photographs is a fundamental beginning stage in electronic screening for diabetic retinopathy (DR), a commonplace complexity of diabetes. The goal of ROC is to deal with a couple of competitions, focussed on various basic troubles in motorized acknowledgment of retinal ailment. In this work they present the results of the essential widespread microaneurysm acknowledgment competition, dealt with concerning the Retinopathy Online Challenge (ROC), a multiyear online test for various pieces of DR recognizable proof.

Jaydeep De have proposed a Tracing retinal vessel tree by transudative inference which is used trace the retinal vessel in order to find the microaneurysms. Diabetic retinopathy (DR) is one of the intricacies of diabetes. Analysis of DR is performed by the assessment of retinal (fundus) pictures. The nearness of microaneurysms (MAs) on the retina is the first and most trademark side effect of this sickness. In this paper, they inspect the issue of mechanized retinal MA recognition, and propose a strategy for this errand, which ended up being exceedingly focused with the vast majority of the best-in-class ones, in light of the consequences of an open online challenge. For clamor decrease, convolution with Gaussian veils and middle separating are generally connected techniques.

CAD Architecture

CAD system consists of domain expert, designer, inference engine, knowledge base, user interface and user. There is a relationship between these subdivisions which makes it a CAD system. The domain expert is connected to the knowledge base in order to give rules and facts. The domain experts are normally the expert in the body or field. The knowledge base stores the rules and facts collected. The knowledge base is also connected to an inference engine in which is used to process the rule to deduce another set of rules or fact. The inference engine is normally designed by the programmer or designer. The inference engine is then connected to the user interface in which is used to collect data from the users. This is also developed by the designer. This can be taken backward also, where the user interface gives information to the inference engine and the knowledge base for the user data to be processed. Also, for the knowledge base update, a need to contact the domain expert is needed.

Approach

In general, the existing process of CAD system that automatically detects the diseases, mainly includes three steps. Firstly, it's necessary to collect a large number of images and relative experts have to label the characteristic lesions. It is fundamental but very crucial. Secondly, computers extract the features of disease through a particular program based on the input of marked images. Finally, a given image can be distinguished from any kind of disease by feature of target lesions

Disadvantages

Limited Interoperability

Today's EMR Systems, and the lack of interoperability between these systems, reveals that healthcare has fundamental problems to address to improve interoperability, including standardization of terminology and normalization of data to those standards. While the EMR was created by and for a single provider (**Regenstrief Institute**), most systems available today generate tremendous amounts of data, while lacking the necessary tools for data analytics and integration. Expand the number of providers, systems, and data sources, and the record quickly becomes a collection of disparate low-quality data that is a major contributor to provider discontent and burnout.

Workflow Disruption

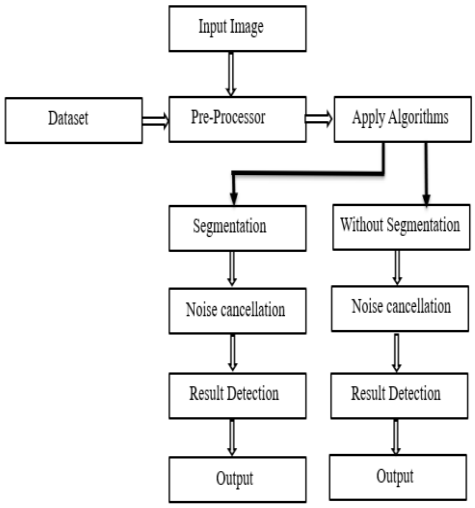
An ***Agency for Healthcare Research & Quality*** study found workflow is significantly affected when new health technology is introduced. This causes interruptions throughout the clinical process and all work roles. ***Fierce EMR*** reports the study focused on six ambulatory practices from two participating healthcare organizations, three each on the East and West coasts. This included 120 clinicians and clinic staff. The results showed implementation of new technology changed the way each of these organizations operated. For example, clinicians' and clinic staff's time on different clinical tasks was redistributed and workspaces were used differently.

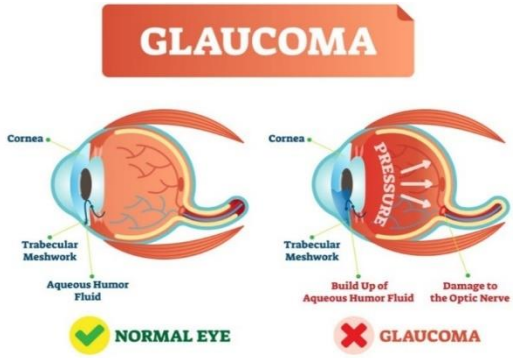
Poor Reimbursement

Healthcare reimbursement describes the payment that your hospital, healthcare provider, diagnostics facility, or other healthcare providers receive for giving you a medical service. Often, your health insurer or a government payer covers the cost of all or part of your healthcare. Depending on your health plan, you may be responsible for some of the cost, and if you don't have healthcare coverage at all, you will be responsible to reimburse your healthcare providers for the whole cost of your health care.

Proposed System

The proposed system attempts to classify and predict the preclinical signs of the diseases. The proposed system attempts to classify and predict the preclinical signs of the diseases. Several Machine Learning approaches have been successfully applied in ophthalmology. However, most of the Machine Learning models have been centered in diagnosis and they typically perform better for diagnosis because disease signs are already present and identifiable by human experts. Our proposed Diabetic framework has image processing technique using a Haar algorithm and classification is done by using open CV.





Our ultimate goal of this project is to make use of this project to common people in urban and rural area who all don't have enough money to consult high specialist hospitals to make a common eye check-up. For this reason, we planned to implement our project called "The early predictor of retinal disease symptoms by image processing "in a vending machine concept with coin dispenser. By spending less amount common people can use this vending machine and check whether they have symptoms of most alarming and dangerous retinal diseases, such as

1.DIABETIC RETINOPATHY

2. GLAUCOMA

3.STRIBISMUS

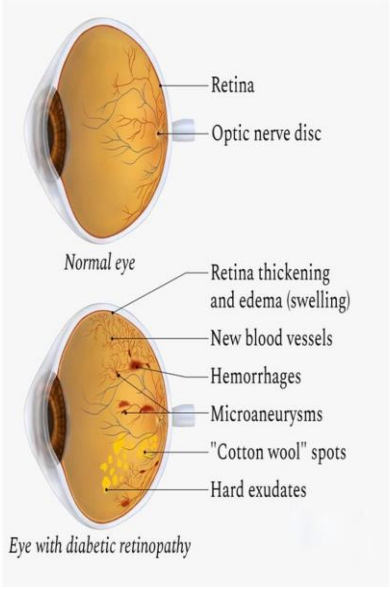
4.EYE FLOATERS

Glaucoma:

Glaucoma is a condition that damages your eye's optic nerve. It's buildup of pressure inside your eye. The increased pressure in your eye, called intraocular pressure, can damage your optic nerve, which sends images to your brain. Glaucoma can cause permanent vision loss. It has no early symptoms and pains. But it can be inherited.

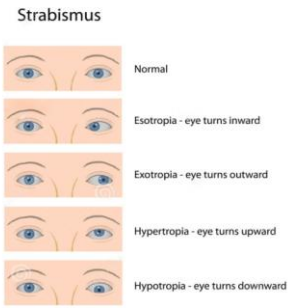
Diabetic Retinopathy:

The retina is at the back of both eyes like a thin lining. It helps in transforming light and sending signals to the brain. If this retina is harmed, the brain cannot decode the signals leading to a disease called retinopathy. Diabetic patients are the most prone to this disease, and it is termed Diabetic Retinopathy. Diabetic retinopathy is vision loss or even blindness caused to high diabetic patients.



Strabismus: (Crossed Eye)

Strabismus is a condition in which eyes do not line up with one another. In the other word, one eye is turned in a direction that is different from the other eye. Under normal conditions, the six muscles that control eye movement work together and point both eyes at the same directions. Strabismus is often inherited, with about 30 percent of children with strabismus having a family member with a similar problem.



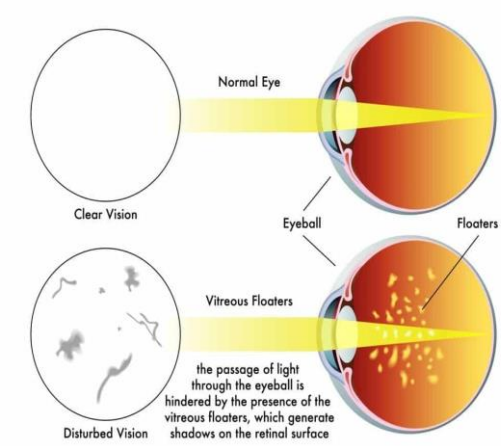
Eye Floaters:

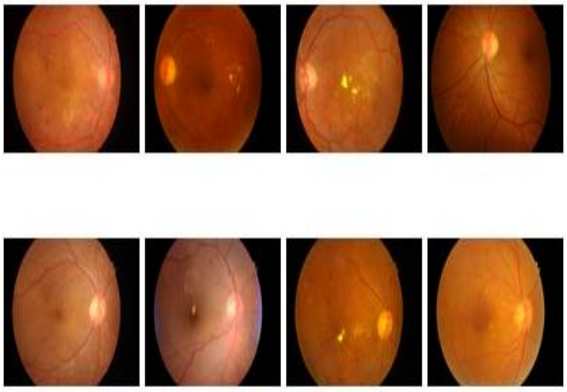
Eye floaters appear as small spots that drift through your field of vision. They may stand out when you look at something bright, like white paper or a blue sky. If you have a large floater, it can cast a slight shadow over your vision. But this tends to happen only in certain types of light. They come in many different shapes:

1. Black or gray dots

2. Squiggly lines

3. Cobwebs and Rings



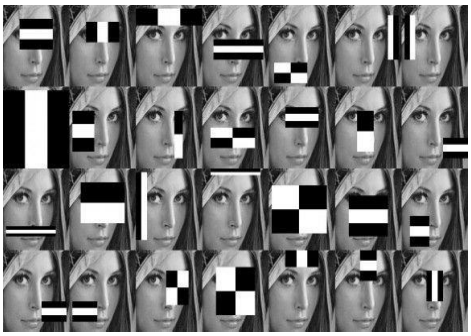


Module Description

As we have decided to implement this project in an image processing technique, we need of an algorithm to process the image captured. So, we have researched about so many algorithms technique most popularly used for image processing we come to know about popular algorithms that is

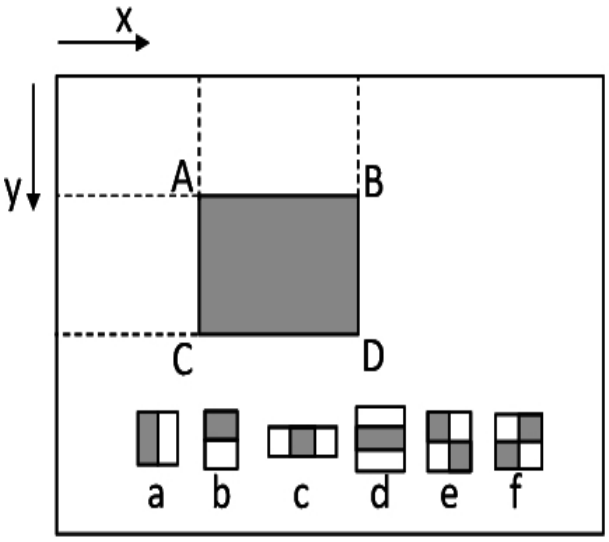
HAAR CASCADE ALGORITHM

In our project we are using Haar algorithm for image processing. Let's proceed detailed description about HAAR ALGORITHM. One of the primary benefits of HAAR algorithm is One of the primary benefits of Haar cascades is that they are just so fast — it's hard to beat their speed.



A general representation of training a Haar Classifer. The algorithm can be explained in four stages:

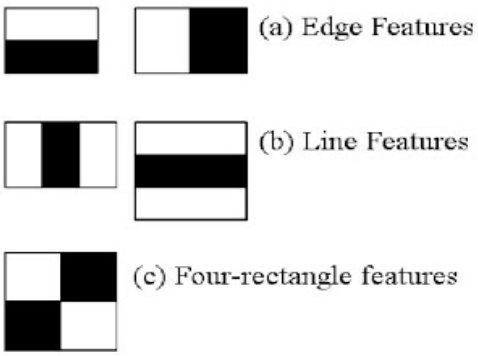
- Calculating Haar Features
- Creating Integral Images
- Using Adaboost
- Implementing Cascading Classifiers



It's important to remember that this algorithm requires a lot of **positive images** of faces and **negative images** of non-faces to train the classifier, similar to other machine learning models.

Calculating Haar Features

The first step is to collect the Haar features. A **Haar feature** is essentially calculations that are performed on adjacent rectangular regions at a specific location in a detection window. The calculation involves summing the pixel intensities in each region and calculating the differences between the sums. Here are some examples of Haar features below.



These features can be difficult to determine for a large image. This is where **integral images** come into play because the number of operations is reduced using the integral image.

Creating Integral Images

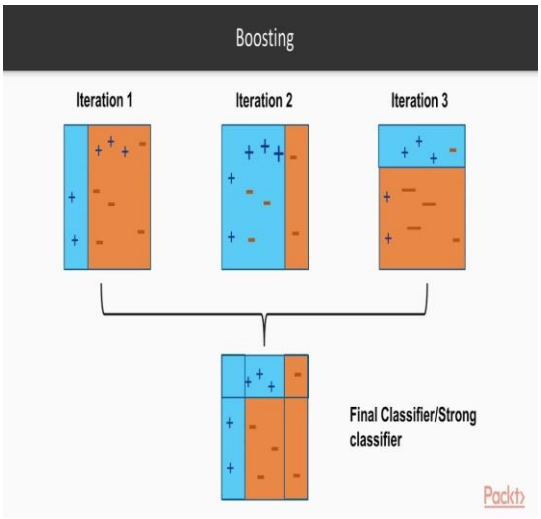
Without going into too much of the mathematics behind it (check out the paper if you're interested in that), integral images essentially speed up the calculation of these Haar features. Instead of computing at every pixel, it instead creates sub-rectangles and creates array references for each of those sub-rectangles. These are then used to compute the Haar features**.**

It's important to note that nearly all of the Haar features will be **irrelevant** when doing object detection, because the only features that are important are those of the object. However, how do we determine the best features that represent an object from the hundreds of thousands of Haar features? This is where **Adaboost** comes into play.

Adaboost Training

Adaboost essentially chooses the best features and trains the classifiers to use them. It uses a combination of **"weak classifiers"** to create a **"strong classifier"** that the algorithm can use to detect objects.

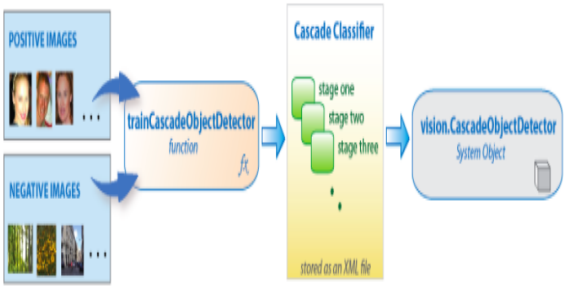
Weak learners are created by moving a window over the input image, and computing Haar features for each subsection of the image. This difference is compared to a learned threshold that separates non-objects from objects. Because these are "weak classifiers," a large number of Haar features is needed for accuracy to form a strong classifier



Implementing Cascading Classifiers

The cascade classifier is made up of a series of stages, where each stage is a collection of weak learners. Weak learners are trained using boosting, which allows for a highly accurate classifier from the mean prediction of all weak learners. Based on this prediction, the classifier either decides to indicate an object was found (positive) or move on to the next region (negative). Stages are designed to reject negative samples as fast as possible, because a majority of the windows do not contain anything of interest. It's important to maximize a **low false negative rate**, because classifying an object as a non-

object will severely impair your object detection algorithm. A video below shows Haar cascades in action. The red boxes denote “positives” from the weak learners. Haar cascades are one of many algorithms that are currently being used for object detection. One thing to note about Haar cascades is that it is very important to **reduce the false negative rate**, so make sure to tune hyperparameters accordingly when training your model.



Results and Discussion

Raspberry PI

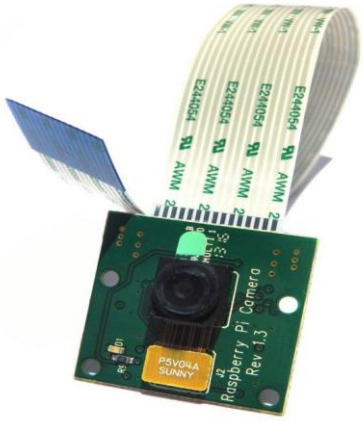
The Raspberry Pi 4 Model B is the latest version of the low-cost Raspberry Pi computer. The Pi isn't like your typical device; in its cheapest form it doesn't have a case, and is simply a credit-card sized electronic board -- of the type you might find inside a PC or laptop, but much smaller.

The Raspberry Pi 4 can do a surprising amount. Amateur tech enthusiasts use Pi boards as media centers, file servers, retro games consoles, routers, and network-level ad-blockers, for starters. However, that is just a taste of what's possible. There are hundreds of projects out there, where people have used the Pi to build tablets, laptops, phones, robots, smart mirrors, to take pictures on the edge of space, to run experiments on the International Space Station -- and that's without mentioning the wackier creations

Rapbery Pi Camera

The Raspberry Pi Camera Board plugs directly into the CSI connector on the Raspberry Pi. It's able to deliver a crystal clear 5MP resolution images, or 1080p HD video recording at 30fps! Latest Version 1.3! Custom designed and manufactured by the Raspberry Pi Foundation in the UK, the Raspberry Pi Camera Board features a 5MP (2592:1944 pixels) Omnivision 5647 sensor in a fixed focus module.

The module attaches to Raspberry Pi, by way of a 15 Pin Ribbon Cable, to the dedicated 15-pin MIPI Camera Serial Interface (CSI), which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data to the BCM2835 processor.



IR SENSOR

IR technology is used in daily life and also in industries for different purposes. For example, TVs use an IR sensor to understand the signals which are transmitted from a remote control. The main benefits of IR sensors are low power usage, their simple design & their convenient features. IR signals are not noticeable by the human eye. The IR radiation in the electromagnetic spectrum can be found in the regions of the visible & microwave. Usually, the wavelengths of these waves range near-infrared, mid, and far-infrared. The near IR region’s wavelength ranges from 0.75 – 3µm, the mid-infrared region’s wavelength ranges from 3 to 6µm & the far IR

region's infrared radiation's wavelength is higher than 6µm.

LCD DISPLAY

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden. For instance: preset words, digits, and seven-segment displays, as in a digital clock, are all good examples of devices with these displays. They use the same basic technology, except that arbitrary image are made from a matrix of small pixels, while other displays have larger elements.

Conclusion and Future Work

The equipment's we are using in our project are cost benefit and giving accuracy results because the PI camera captures resolution with 1080p at 25 frames. It captures 500's of images and compares using HAAR algorithm technique. Our proposed system helps public to identify some painless eye diseases in their early stage with lower cost. The implementation of Vending Machine concept also gives awareness to the public to know about the importance of the retinal diseases.

The current prototype which we have developed in our project will support only the following diseases such as Diabetic Retinopathy, Glaucoma, Strabismus, Eye Floaters. In future we are planning to implement for more retinal diseases to identify the symptoms. Now our proposed system is designed like a testing prototype in a public places like malls, theatres, bus stops etc.., In further implementation, the idea is to implement in a real time process. By using high-tech equipment like fundus camera or retinal camera, which is to establish a baseline to judge later whether a disease is progressive.

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