JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

PREDICTION OF RETINAL DISEASES USING IMAGE PROCESSING TECHNIQUES

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ABSTRACT

"CLEAR VISION GIVES YOU A CLEAR LIFE", this wording means a lot. Every person wishes to have a good vision to survive, enjoy, and have a peaceful life and most people do the same. A promising good vision is presented by a good retina and its retinal health. As a coin has two sides some diseases 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, they cause serious problems and affect vision, some even leading to blindness. Ones if people are affected with a retinal disease they come to know after a severe effect on 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 a 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 the 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 a working model of the vending concept and to keep it in public places and allow common people to utilize it with less cost and with minimum handling. We have analyzed so many algorithms to implement our idea, finally, we are satisfied with HAAR CASCADE ALGORITMH 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 undergo a dual segmentation process for further classification whereas other image processing algorithms will lie under with segmentation and without segmentation processing and it will consume more time. Some other ML algorithms will demand a fundus image for image processing later it will convert the color image to a grayscale image using a scanner, but the HAAR Algorithm does not demand it For all these reasons we have chosen HAAR ALGORITHM and it also satisfies our needs to the extend. We are using OpenCV which is an open-source computer vision for implementing the programming which will be developed in Python language. We have chosen OpenCV because it is platform-independent and it already has 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, has huge processing power in a compact board, and has many interfaces. We are using PI CAMERA for image capture resolution with 1080p at 25 frame PI CAMERA has a better graphic processing capability than others.

INTRODUCTION

Introduction: The human eye is a remarkable organ, but its complex structure also makes it susceptible to various diseases, some of which can be subtle and painless, making them difficult to detect until they've significantly progressed. This delayed diagnosis can result in irreversible damage and even vision loss. Among these conditions, diabetic retinopathy and glaucoma are particularly concerning due to their prevalence and potential severity.

Diabetic retinopathy is a complication of diabetes that affects the blood vessels in the retina. It can lead to vision impairment and blindness if left untreated. Glaucoma, on the other hand, is a group of eye conditions that damage the optic nerve, often due to increased pressure within the eye. It is a leading cause of irreversible blindness worldwide.

Early detection of these conditions is crucial for effective management and prevention of vision loss. However, traditional screening methods may not always catch subtle signs of disease, especially in the early stages when intervention is most beneficial.

To address these challenges, our model leverages the power of machine learning algorithms, particularly those used in image processing and analysis. By training these algorithms on large datasets of retinal images, they can learn to identify subtle patterns and abnormalities indicative of diabetic retinopathy and glaucoma.

For diabetic retinopathy, the algorithm can detect changes in the retinal blood vessels, such as microaneurysms, hemorrhages, and exudates, which are characteristic signs of the disease. Similarly, for glaucoma, the algorithm can analyze the optic nerve head and surrounding structures for signs of damage or thinning.

By automating this process, our model streamlines the screening and diagnosis of these retinal diseases, allowing for earlier detection and intervention. Patients can undergo routine retinal imaging, and the algorithm can quickly analyze the images, flagging any concerning findings for further evaluation by a healthcare professional.

This approach not only improves the efficiency of screening programs but also enhances their accuracy and sensitivity, reducing the likelihood of missed diagnoses or false positives. Ultimately, by enabling early detection and intervention, our model aims to preserve vision health, improve patient outcomes, and reduce the burden of diabetic retinopathy and glaucoma on individuals and healthcare systems alike.

KEYWORDS

Clear vision, Retinal health, Retinal diseases, Early predictor, Image processing, Haar cascade algorithm, Machine learning, OpenCV, Python programming, Raspberry Pi, SOC (System on Chip), Pi Camera

RELATED WORK

Related Work: Related work in the field of automated retinal disease detection and diagnosis has shown promising advancements, with various studies focusing on the application of machine learning algorithms to analyze retinal images for early detection of diabetic retinopathy and glaucoma.

One notable study by Gulshan et al. (2016) demonstrated the effectiveness of a deep learning algorithm in detecting diabetic retinopathy from retinal images with high sensitivity and specificity, rivaling the performance of expert ophthalmologists. This study highlighted the potential of deep learning techniques, particularly convolutional neural networks (CNNs), in automating the screening process for diabetic retinopathy.

Similarly, Ting et al. (2017) proposed a deep learning-based system for the automated detection of glaucoma from optical coherence tomography (OCT) images of the optic nerve head. Their approach achieved high accuracy in distinguishing between healthy and glaucomatous eyes, showcasing the potential of deep learning in aiding early diagnosis of glaucoma.

Other researchers have explored the use of machine learning algorithms, such as support vector machines (SVMs) and random forests, for the detection of diabetic retinopathy and glaucoma from fundus images. These studies have shown promising results in terms of accuracy and efficiency, further validating the feasibility of automated retinal disease screening using machine learning techniques.

Furthermore, efforts have been made to develop integrated systems that combine image analysis algorithms with telemedicine platforms, allowing for remote screening and diagnosis of retinal diseases in underserved populations. These systems aim to address barriers to access and facilitate early intervention for individuals at risk of vision loss due to diabetic retinopathy and glaucoma.

Overall, the existing body of research underscores the potential of machine learning and image-processing technologies in revolutionizing the detection and management of retinal diseases. By building upon these advancements and addressing remaining challenges, such as scalability and interpretability, we can further enhance the effectiveness of automated retinal disease screening and contribute to improved vision health outcomes globally.

DESCRIPTION

Our proposed system for free medical screening of Glaucoma and Diabetic Retinopathy is designed to be easily accessible in any public service setting. It offers a straightforward yet comprehensive solution for early detection of these sight-threatening conditions.

The system comprises two main components:

1. *Feature Extraction using Cascade Algorithm:* This component focuses on extracting relevant features from retinal images using the efficient Haar Cascade Algorithm. The algorithm efficiently identifies key patterns and structures in the images that are indicative of Glaucoma and Diabetic Retinopathy. These features may include characteristics such as microaneurysms, hemorrhages, exudates, optic nerve head abnormalities, and thinning of the retinal nerve fiber layer. The Haar Cascade Algorithm's speed and simplicity make it ideal for real-time analysis of large volumes of retinal images, enabling rapid screening with minimal delay.

2. *Machine Learning-Based Data Analysis:* Once the features are extracted, the system utilizes machine learning techniques for data analysis and prediction. These techniques involve training algorithms on labeled datasets of retinal images, allowing them to learn to distinguish between healthy retinas and those exhibiting signs of Glaucoma or Diabetic Retinopathy. The trained models can then analyze new retinal images and provide predictions regarding the presence or absence of these conditions. By leveraging machine learning, the system can achieve high accuracy in identifying early signs of Glaucoma and Diabetic Retinopathy, facilitating timely intervention and treatment.

In addition to these technical components, the system includes user-friendly interfaces to facilitate seamless interaction and interpretation of diagnostic results. The diagnostic results are presented clearly and understandably, enabling both healthcare professionals and individuals to interpret the findings accurately. Moreover, the system may incorporate features such as automated appointment scheduling or referral to specialized healthcare providers for further evaluation and management, enhancing the overall user experience and healthcare delivery process.

Overall, our proposed system offers a simple yet effective solution for early screening of Glaucoma and Diabetic Retinopathy in public service settings, empowering individuals to proactively manage their eye health and prevent vision loss.

EXISTING SYSTEM

AI-assisted automated screening and diagnosis of common diseases in ophthalmology are helping to maximize the doctor’s role at the clinic. This increased usage of AI in medicine not only helped in the 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 reduce the obstacles for them to access for eye care where an ophthalmologist is not available.

COMPUTER-AIDED DIAGNOSIS (CAD)

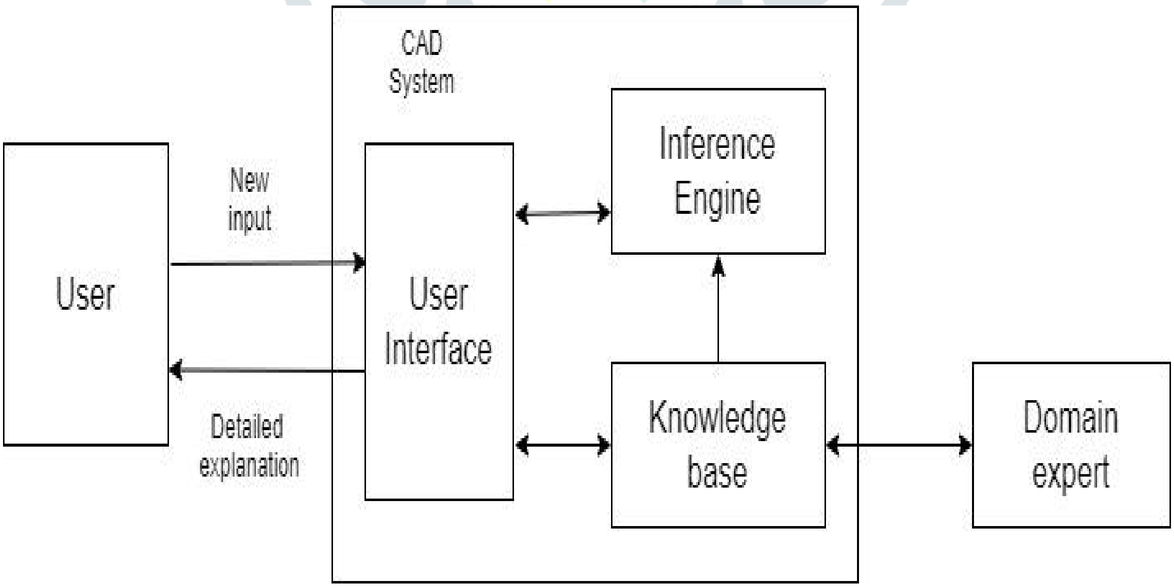
The existing Computer Aided Diagnosis (CAD) is a piece of software programmed using Artificial Intelligence (AI) techniques. Such CAD systems make use of expert knowledge to offer advice or make decisions in areas like medical diagnosis. With the CAD, the user can interact with the computer to solve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

CAD ARCHITECTURE

CAD system consists of a domain expert, designer, inference engine, knowledge base, user interface, and user. There is a relationship between 15 of 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 experts in the body or field. The knowledge base stores the rules and facts collected. The knowledge base is also connected to an inference engine which is used to process the rule to deduce another set of rules or facts. The inference engine is normally designed by the programmer or designer. The inference engine is then connected to the user interface 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



DESCRIPTION

The Computer-Aided Diagnosis (CAD) system comprises a domain expert providing expertise stored in the knowledge base, processed by the inference engine designed by the programmer, facilitating user interaction through the user interface. This interconnected architecture allows users to input data, receive recommendations, and update the system as necessary. The CAD system's effectiveness relies on seamless communication between components, where the domain expert informs the knowledge base, the inference engine processes information, and the user interface facilitates interaction. Regular updates, including feedback from users and domain experts, ensure the CAD system remains accurate and relevant in its diagnostic capabilities.

DRAWBACKS

1. Dependence on Expert Knowledge: CAD systems rely heavily on experts to provide rules and facts, which can limit their adaptability and require frequent updates.

2. Limited Generalization: These systems may struggle to detect new or rare diseases and variations in image quality, demographics, and disease presentation.

3. Complex Feature Extraction: Extracting relevant features from images can be difficult, especially for subtle or early signs of disease, potentially leading to inaccurate diagnoses.

4. Interpretability Issues: CAD systems often operate as black-box models, making it hard for clinicians to understand and trust their recommendations.

5. Integration Challenges: Integrating CAD systems into existing clinical workflows and ensuring data privacy and compliance with regulations can be complex and require careful planning.

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

MERITS

1. Accessibility: Our system can be used anywhere for free, ensuring everyone can get screened for Glaucoma and Diabetic Retinopathy easily.

2. Affordability: It's free, so people don't have to worry about paying for the screening.

3. Early Detection: Our system catches eye problems early, so people can get treatment before things get worse.

4. Accuracy: It's good at finding eye problems, so you can trust the results.

5. Easy to Use: The system is simple to understand and use, so anyone can do it without any trouble.

6. Works for Everyone: It can help a lot of people, even in places where there aren't many doctors or eye clinics.

7. Helps Prevent Problems: Finding issues early, helps keep people's eyes healthy and prevents big problems later on.

MODULE DESCRIPTION

1	Raspberry pi
2	Pi camera
3	IR sensor
4	LCD display

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 game 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 more wacky creations.

With the Pi 4 is faster, able to decode 4K video, benefiting from faster storage via USB 3.0, and faster network connections via true Gigabit Ethernet, the door is open to many new uses. It's also the first Pi that supports two screens at one to dual 4K@30 displays -- a boon for creatives who want more desktop space.

RASPBERRY PI CAMERA

The Raspberry Pi Camera Board plugs directly into the CSI connector on the Raspberry Pi. It's able to deliver 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.

The board itself is tiny, at around 25mm x 20mm x 9mm, and weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. The sensor itself has a native resolution of 5 megapixels and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944 pixel static images and also supports 1080p @ 30fps, 720p @ 60fps, and 640x480p 60/90 video recording.

The camera is supported in the latest version of Raspbian, the Raspberry Pi's preferred operating system.

The Raspberry Pi Camera Board Features:

- Fully Compatible with Both the Model A and Model B Raspberry Pi
- 5MP Omnivision 5647 Camera Module
- Still Picture Resolution: 2592 x 1944
- Video: Supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 Recording
- 15-pin MIPI Camera Serial Interface - Plugs Directly into the Raspberry Pi Board
- Size: 20 x 25 x 9mm
- Fully Compatible with many Raspberry Pi cases

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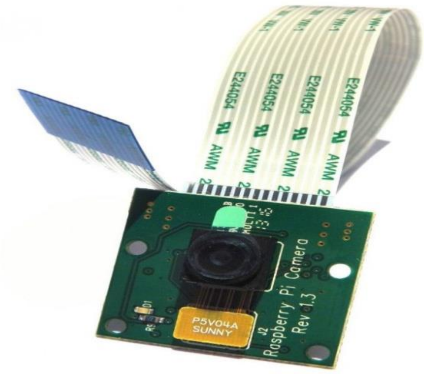
- Size: 20 x 25 x 9mm
- Weight 3g
- Fully Compatible with many Raspberry Pi cases



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 that 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 to 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 from 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 reflectorto 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 images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character-positive LCD with a backlight will have black lettering on a background that is the colour of the backlight, and a character-negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white-on-blue LCDs to give them their characteristic appearance.

CONCLUSION AND FUTURE WORK

In our implementation, we are using HAAR CASCADE ALGORITHM which is a MACHINE LEARNING technique – it's hard to beat their speed. The cost emission and the accuracy level is higher than the existing system. It is also an eco-friendly platform for the public.

The equipment we are using in our project is cost-effective and gives accurate results because the PI camera captures a resolution 1080p at 25 frames. It captures 500 images and compares them using the HAAR algorithm technique. Our proposed system helps the public to identify some painless eye diseases in their early stage at a lower cost.

The implementation of the VENDING MACHINE concept also gives awareness to the public about the importance of retinal diseases.

The current prototype that we have developed in our project will support only the following diseases Diabetic Retinopathy, Glaucoma, Strabismus, and Eye Floaters. In the future, we are planning to implement more retinal diseases to identify the symptoms. Now our proposed system is designed like a testing prototype in 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 a fundus camera or retinal camera, which is to establish a baseline to judge later whether a disease is progressive.

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