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Novel Approach of Automatic Disease Prediction and Regular Check-up System Using ML/DL

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Abstract : The important objective of this system is to provide an accurate prediction of disease like Pneumonia, Fungal Infection, AIDS, Migraine, Jaundice, Common Cold, Heart Attack, Acne, COVID-19, etc. This system will also give the regular check-up report of the user. As the doctor may not be available always when needed, but in the modern time scenario, according to necessity one can always use this prediction and regular check-up system anytime. The healthcare industry produces large amounts of healthcare data daily that can be used to extract information for predicting disease that can happen to a user in future while using the treatment history and health data. The symptoms of the individual along with the current images of them are given to the ML and DL model to further process. After preliminary processing of the data collected, the ML model uses the current input, trains and tests the algorithm resulting in the predicted disease. The current images are taken for the regular health care check-up and here the user is not expected to give the symptoms because the regular check-up will be purely based on the current scenario of the user. The inputs are then used by the ML model which trains and tests with the algorithm resulting in the health check-up graph.

I. INTRODUCTION

Disease prediction using patients treatment history and health data by applying different machine learning techniques is an ongoing struggle for the past few decades. Machine learning is programming computers to optimize a performance using example data or past data. Machine learning is a study of computer systems that learn from data and experience. Many works have been applied data mining techniques to pathological data or medical profiles for prediction of specific diseases. Some of the approaches try to do prediction on control and progression of disease. The recent success of deep learning in disparate areas of machine learning has driven a shift towards machine learning models that can learn rich, hierarchical representations of raw data with little pre-processing and produce more accurate results.

Medical facilities need to be advanced so that better decisions for patient's diagnosis and treatment options can be made. Machine learning and healthcare are some of the most crucial parts of the economy and human life. In today's era, where everything has turned virtual, the doctors and the nurses are putting up maximum efforts to save people's lives even if they have to danger their own. There are also some remote villages that lack medical facilities. Machine learning in healthcare aids the humans to process huge and complex medical datasets and then analyze them into clinical insights. A disease predictor can be called a virtual doctor, which can predict the disease of any patient without any human error. Also in conditions like COVID-19 and EBOLA, a disease predictor can be a blessing as it can identify a human's disease without any physical contact.

A disease predictor will predict the disease accurately of the patient or the user based on the information or the symptoms he/she enter into the system. This predictor can also be used when the user's condition is not serious and if he/she just wants to know the disease, he/she has been suffering from. In the modern era, the doctors are adopting many scientific technologies and methodologies for both identification and diagnosing not only common diseases, but also many fatal diseases. This predictor can help the doctors to take accurate decisions while diagnosing the disease of a patient, therefore disease prediction systems which use machine learning algorithms assist in such cases to get accurate results.

Sometimes, people do not have much time to visit a doctor for just a regular check-up. They usually skip the regular check-up which is generally recommended by the doctors. A regular check-up system will focus on the current scenario of the user and give out the health check-up graph of the particular user in no time. This regular health check-up system will take the current scenario as an input in the form of a video and some images of body parts like face, tongue, eyes, nails, etc. and process it to give a regular health check-up graph.

II. EXISTING SYSTEM

Title:-"Disease prediction based on symptoms."
Author:-Aditya Arya, Sudhanshu, Rohan Agarwal
Description:- Health information needs are also changing the information seeking behavior and can be observed around the globe. Challenges faced by many people are looking online for health information regarding diseases, diagnoses and different treatments. If a recommendation system can be made for doctors and medicine while using review mining will save a lot of time. In this type of system, the user face problems in understanding the heterogeneous medical vocabulary as the users are laymen. User is confused because a large amount of medical information on different mediums is available. The idea behind recommender system is to adapt to cope with the special requirements of the health domain related with users.

Title:-"Measuring Heart Rate from Video"
Author:-Isabel Bush
Description:- A non-contact means of measuring heart rate could be beneficial for sensitive populations, and the ability to calculate pulse using a simple webcam or phone camera could be useful in telemedicine. Previous studies have shown that heart rate may be measured in color video of a person's face. This paper discusses the reimplementation of such approach that uses independent component analysis on mean pixel color values within a region of interest (ROI) about the face. We explore the idea further by assessing the algorithm's robustness to subject movement and bounding box noise and examine new means of choosing the ROI, including segmentation of facial pixels through a reimplementation of GrabCut. Heart rate was measured with an error of 3.4 ± 0.6 bpm in still video and 2.0 ± 1.6 bpm in video with movement. Facial segmentation improved the robustness of the algorithm to bounding box noise.

Title:-"Disease Diagnosis for Various Signs Using Tongue Color Image Segmentation"
Author:-G. Uma Devi, Dr. T. Ravi
Description:- Today's high-tech health care worlds professionals are diagnosis the diseases with connectivity of body part one from another. The rolling tongue is many relationships and active connections in the physical body. The snap of tongue images need some specific look in the field of medical image processing and disease analysis. Tongue diagnosing plays vital role to carry out by practical understanding of the tongue, but tongue image processing is not an easy task to carry out. The main focus of our paper deals threshold of tongue signs for diagnosis the diseases. The signs classifies the tongue irregular shape, overlapping of colors, saliva on cracks, buds, pimples etc. Each signs have unique character reflections and issues. This sign factor consists of several phases; quantitative features textures measures for tongue image acquisition by using image processing and crack segmentation. Qualitative features, tongue schema edge detection and region growing algorithm. Mixed color features, pimple detection with association of color intensity extraction method and set algorithm. During the extraction, expected segmentation results will be proved. So, vast majority of the ill can discover effectively by the examination of the tongue.

Title:-"Nail Based Disease Analysis at Earlier Stage Using Median Filter in Image Processing"
Author:-Mrs. D. Nithya, S. Masil Asha, Rupasree Kurapati, Buggareddy Shanmukha Priya, D. Divya
Description:- This paper gives idea to predict diseases using the colour of the nail at early stage of diagnosis. The main aim of the project is to analyze the disease without causing harm to humans. In earlier traditional system of disease detection, doctors observe the nails of patients and will predict the disease. Many diseases can be identified by analyzing nails of patients .But it is difficult for human eyes to differentiate the slight changes in colour. So it is less accurate and time consuming .The proposed system can be quite useful to overcome this issue since it is fully computer based. The input to the proposed system is image of nail which can be captured through web camera. The system will process the nail image and will extract the nail's features to diagnose the disease. Human nail consist of various features, the proposed system uses nail color changes to diagnose the disease. Here, first training set data is prepared from nail images of patients with specific diseases. This training data set is compared with extracted feature from input nail image to obtain the result. In the experiment, we found that training set data are correctly matched with color feature of nail image results. It is focused on the system of image recognition on the basis of color analysis. The proposed system is based on the algorithm which automatically extracts only nails' area from scanned back side of palm (Region of Interest). These selected pixels are processed for further analysis using median filters. The system is fully computer based, so even small discontinuities in color values are observed, and we can detect color changes in the initial stage of disease. By this way, this system is useful in prediction of diseases at their initial stages.

Title:-"Tongue Image Analysis for COVID-19 Diagnosis and Disease Detection"
Author:-Sanjana Dulam, Varsha Ramesh, Malathi G
Description:- Tongue analysis is an effective indicative strategy for assessing the state of the internal organs and to detect associated diseases. In this paper, we propose a disease detection method with the use of a regular smartphone and to track disease on the go. Colour, texture and geometric features are extracted from the images of the tongue captured and are used to train classification models to detect associated diseases. The primary objective of this paper is to classify images of tongues which are healthy or are diagnosed with either thyroid, heart disease or gastritis. The secondary objective is to perform comparative analysis of machine learning algorithms to find the best performing models and their differences in hope to achieve better performance than those which have been achieved till date. In addition, this paper also takes into consideration the recent breakout, COVID-19, and aims to identify features which potentially help to classify tongues of patients who have been diagnosed with this pandemic.

III. PROPOSED SYSTEM

This system is used to predict many diseases like skin diseases, cold, stomach diseases, chronic diseases, diabetes, brain disorders, AIDS, COVID-19, etc. This system also gives the regular check-up of the user in no time. It accepts the structured and textual type of data as well as the images are processed to predict the diseases. These images includes face, tongue, eyes, nails, etc. This system will predict the diseases based on the symptoms as well as the current scenario of the user. This disease predictor and regular check-up system uses machine learning as well as deep learning technologies. For predicting diseases Random Forest algorithm is used, for image processing CNN algorithm is used and for video processing we will first detect the facial region in each frame of the video, then the desired region of interest (ROI) within the face bounding box must be chosen. Then the plethysmographic signal must be extracted from the change in pixel colors within the ROI overtime and analyzed to determine the prominent frequency within the heart rate range.

A. Random Forest

Random forest is a supervised learning algorithm. The "forest" it builds, is an ensemble of decision trees, usually trained with the “bagging” method. The general idea of the bagging method is that a combination of learning models increases the overall result. Random forest is a flexible, easy to use machine learning algorithm that produces, even without hyper-parameter tuning, a great result most of the time. It is also one of the most used algorithms, because of its simplicity and diversity. It can be used for both classification and regression tasks.

One big advantage of random forest is that it can be used for both classification and regression problems, which form the majority of current machine learning systems. In fig-1 below you can see how a random forest would look like with two trees:

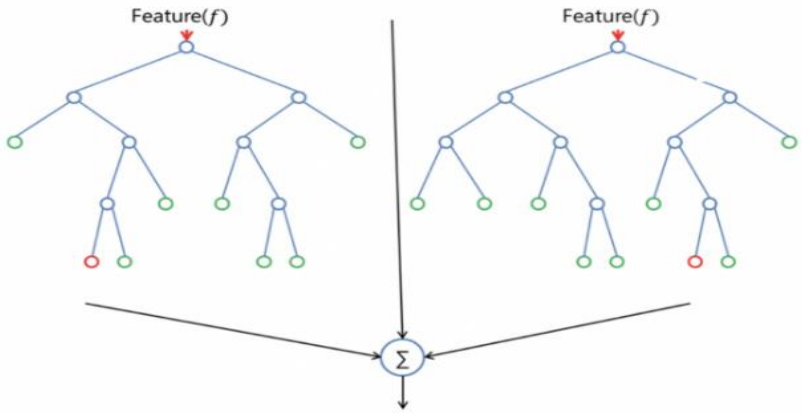

fig-1: random forest with two trees

Random forest has nearly the same hyperparameters as a decision tree or a bagging classifier. Fortunately, there's no need to combine a decision tree with a bagging classifier because you can easily use the classifier-class of random forest. With random forest, you can also deal with regression tasks by using the algorithm's regressor.

Random forest adds additional randomness to the model, while growing the trees. Instead of searching for the most important feature while splitting a node, it searches for the best feature among a random subset of features. This results in a wide diversity that generally results in a better model.

Therefore, in random forest, only a random subset of the features is taken into consideration by the algorithm for splitting a node. You can even make trees more random by additionally using random thresholds for each feature rather than searching for the best possible thresholds (like a normal decision tree does).

B. CNN

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics.

The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlap to cover the entire visual area.

A ConvNet is able to successfully capture the Spatial and Temporal dependencies in an image through the application of relevant filters. The architecture performs a better fitting to the image dataset due to the reduction in the number of parameters involved and reusability of weights. In other words, the network can be trained to understand the sophistication of the image better.

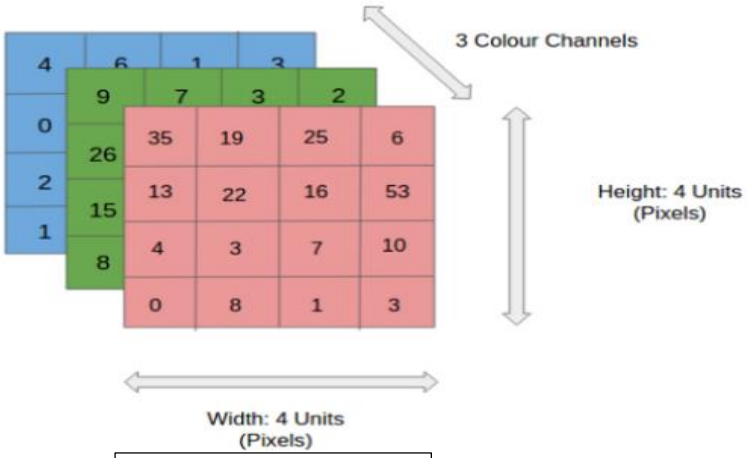

fig-2: 4x4x3 RGB image

In the fig-2, we have an RGB image which has been separated by its three color planes — Red, Green, and Blue. There are a number of such color spaces in which images exist — Grayscale, RGB, HSV, CMYK, etc.

You can imagine how computationally intensive things would get once the images reach dimensions, say 8K (7680×4320). The role of the ConvNet is to reduce the images into a form which is easier to process, without losing features which are critical for getting a good prediction. This is important when we are to design an architecture which is not only good at learning features but also is scalable to massive datasets.

The analysis of image includes:

1) Image Acquisition

It is the creation of a representation of the visual characteristics of an object, such as a physical scene or the interior structure of an object. The term is often assumed to imply or include the processing, compression, storage, printing, and display of such images. A key advantage of a digital image, versus an analog image such as a film photograph, is the ability to make copies and copies of copies digitally indefinitely without any loss of image quality.

It is the first step in image processing. Commonly this involves pre-processing like scaling etc. The image can be taken as an input through web camera. High resolution images helps in accurate image analysis.

2) Pre-processing

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subfield of digital signal processing, digital image processing has many advantages over analogue image processing. It allows a much wider range of algorithms to be applied to the input data the aim of digital image processing is to improve the image data (features) by suppressing unwanted distortions and/or enhancement of some important image features so that our AI-Computer Vision models can benefit from this improved data to work on. In this step, image data is improved to enhance some image features for further processing. Enhancement, restoration, compression are methods of pre-processing.

3) Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as image objects). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

4) Feature Extraction

This step consists of finding and extracting the features which can be used to determine the meaning of image. The features of an image are various attributes or characteristics of image field. Natural and artificial are the two types of features. Visual appearance of an image is followed in natural while artificial features are result from some manipulations of an image. Natural features includes gray scale textural region, brightness of the region of pixel, edge outline of an object etc. and artificial features includes image amplitude histograms and special frequency spectrum.

5) Comparison with database

The generated output from the phase of feature extraction is then compared with the database to diagnose the disease.

6) Result

By analyzing the result in previous phase disease detection is made.

C. Face Detection And Tracking

In order to locate a human face, the system needs to capture an image using a camera and a frame-grabber to process the image, search the image for important features and then use these features to determine the location of the face. For detecting face there are various algorithms and methods including skin color based, haar like features, adaboost and cascade classifier Color is an important feature of human faces. Using skin-color as a feature for tracking a face has several advantages. Color processing is much faster than processing other facial features. Refer fig-3.

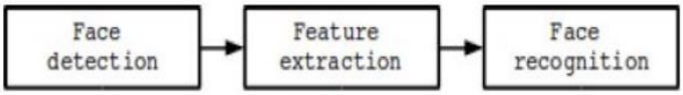

fig-3: generic face recognition system

The input of a face recognition system is always an image or video stream. The output is an identification or verification of the subject or subjects that appear in the image or video.

D. Region of Interest Selection

It is sometimes of interest to process a single subregion of an image, leaving other regions unchanged. This is commonly referred to as region-of-interest(ROI) processing. Image sub regions may be conveniently specified by using *Mathematica* Graphics primitives, such as Point, Line, Circle, Polygon, or simply as a list of vertex positions.

A *region of interest* (ROI) is a portion of an image that you want to filter or perform some other operation on. You define an ROI by creating a *binary mask*, which is a binary image that is the same size as the image you want to process with pixels that define the ROI set to 1 and all other pixels set to 0. You can define more than one ROI in an image. The regions can be geographic in nature, such as polygons that encompass contiguous pixels, or they can be defined by a range of intensities.

E. Heart Rate Detection

Facial ROI selection is used to obtain blood circulation features and get the raw BVP signal, which highly influences the following HR detection steps. First, it affects the tracking directly since a commonly applied tracking method uses first frame ROI. Second, the selected ROI regions are regarded as the source of cardiac information. The pixel values inside a ROI are used for intensity-based methods, while feature point locations inside a ROI are used for motion-based methods. For intensity-based methods, when the selected region of the face is too large, the HR signal may be hidden in background noise. On the other hand, if the selected ROI is too small, the quantization noise caused by the camera may not be fully attenuated by the averaging of pixels intensity inside the ROI. For motion-based methods, significantly more computation time is required for a larger ROI. But there might not be enough feature points for effective motion tracking when the ROI is too small.

This step is similar for both intensity-based methods and motion-based methods. We classify the methods into two groups: box ROI detection and model-based ROI detection. Box ROI is the general area of the face regulated by a rectangle sometimes coupled with skin detection. While model-based ROI detection extracts the accurate face contours.

IV. Conclusion

With this system, higher accuracy as well as simplicity can be achieved. In this methodology we are not using only structured, textual data but also the images as well as the videos of the user, which will provide us the current scenario of the user. We have also combined the structured data and the results of the image processed for better results. None of the existing systems and works is focused on using these different types of data for processing and prediction. Also none of the existing systems and works has taken the regular check-up system into consideration to save the time of the user.

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