Biosc.Biotech.Res.Comm. Special Issue Vol 13 No 14 (2020) Pp-452-457

BBRC
Bioscience Biotechnology Research Communications

Disease Diagnostic System: Abnormalities in Human Nail

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ABSTRACT

Various body parts or organs can be analysed to identify the different diseases in the human body. Fingernail analysis is one of the ways to identify disease in the human body. Nails are the body part which are farthest from the heart and therefore receive oxygen at last. As a result the nails are the first who show the symptoms of a disease in the human body. Fingernails can be easily captured for diagnosis and there are no heavy equipment or no specific conditions required to use nail image for disease diagnosis, like in other tests and scanning processes. Human nails deliver beneficial information about complaints or any nutritive imbalances in the human body depending upon their shape, texture and colour. In human beings, numerous systemic and skin diseases can be easily analyzed through careful examination of nails of both the limbs. A lot of nail illnesses have been found to be primary signs of numerous underlying systemic illnesses. The colour, texture or shape changes in nails are signs of many diseases mainly affecting nails. Considering all these properties of nails a system is proposed that uses digital image processing (DIP) methods for identifying such changes in the human nail to get more precise results and predict numerous diseases effortlessly. With the emerging Internet of Things (IOT) concept the generated report is made available remotely, this will help users to reduce transportation efforts. As the system has to deal with large and private data, the security of data must be ensured. To keep the data confidential, the Blockchain concept which is one of the most emerging concepts in the field of data management is used. The paper contains the implementation of the digital image processing for feature extraction of nail images, usage of IOT (ThingSpeak cloud) for data storage and implementation of Blockchain to keep the system secured and theft free.

KEY WORDS: INTERNET OF THINGS (IOT), IMAGE PROCESSING, THINGSPEAK, RGB VALUES, MEAN PIXEL VALUES, BLOCKCHAIN, HASH KEY.

INTRODUCTION

Nail is one of the physical investigative tools which are normally practiced in Ayurveda where nail can be a strong indicator of likely complaints happening in the human body [1]. Any change in oxygen level in the human body detected by nails is an effective tool to predict the symptoms of a disease [2]. Nails are made up of keratin and protein, and are the basic outer structure of the skin of fingers. Their growth depends on the nutrients, proteins they get from the body, but due to some disease in the human body or due to some environmental factors nail colour, texture, shape may get changed which is the most important indication of presence of disease in humans. Healthy nails are ruddy, smooth, shiny pink in colour and the root part i.e. lunula is half-moon grey [3][4]. In most of the studies it is understood that every disease shows

ARTICLE INFORMATION

Corresponding Author: wazarkarps@rknec.edu
Received 18th Oct 2020 Accepted after revision 27th Dec 2020
Print ISSN: 0974-6455 Online ISSN: 2321-4007 CODEN: BBRCBA

Thomson Reuters ISI Web of Science Clarivate Analytics USA and Crossref Indexed Journal

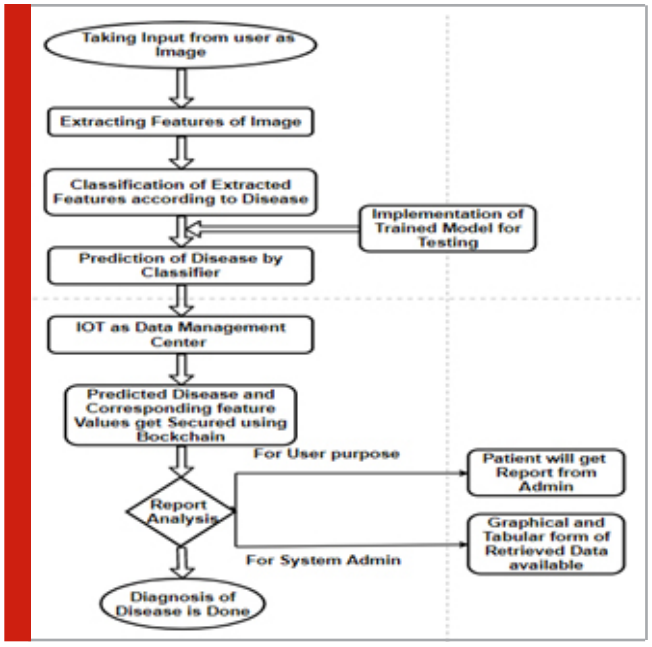
Clarivate Analytics

crossref

NAAS Journal Score 2020 (4.31)

Online Contents Available at: http//www.bbrc.in/
Doi: http://dx.doi.org/10.21786/bbrc/13.14/102

different colours of nails, so any colour change in nails shows an unhealthy status of the human body.



But there are about 16 million colour shades and we as humans hardly differentiate 20-30 shades so it is difficult to diagnose disease on the colour basis in labs, instead of using computers for image processing and differentiating them into the classes of disease is quite simple and efficient. IOT can connect many devices at a time, this makes the system accessible remotely and users can access the report of diagnosis at a remote location. ThingSpeak cloud can be used for accessing IOT to upload data and to retrieve it whenever needed, the retrieved data can be obtained in tabular and graphical form so this will also provide a good analysis of predicted output with given features. The traditional security methods are costly to keep data secured. The emerging concept of Blockchain is always a good option to secure and manage data as it is very difficult to expose the data of blockchain. This paper contributes to predict the disease in the human body based on extracted features of nail image (RGB and mean pixel value) and provides the diagnosed disease based on the prediction made by the classifier. For training and testing supervised vector machine (SVM) classifiers are used. Neural networks can also be used to classify the data [5][6][7].

METHODOLOGY

The designed system takes an image as an input to carry out disease diagnosis, complete process is explained in the following points:-

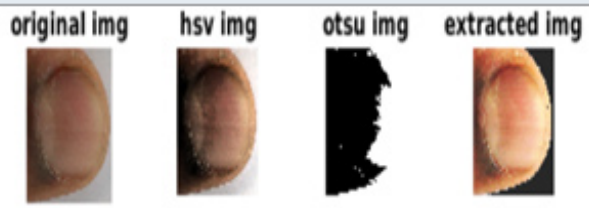
1. Taking user input as image to system, but to have accurate mean pixel value and RGB value contrast of image should be fixed because as contrast increase or decrease there is change in intensity transfer function which eventually leads to change in pixel value of image or brightness value of image may change. To avoid this we use HSV (hue saturation value) colour space and fix the 'V' value to have constant contrast for each input image. Then the image is converted to RGB space again to do further operation.
2. To get exact colour features from images first have to decide region of interest (ROI). Masking the area except ROI (i.e. nail plate area and some root nail area) by using pixel masking technique gives ROI [8] [9]. OTSU technique used to get clear differentiation between foreground and background of image.
3. At this stage image with masked background having ROI is obtained. Now Figure1: Overview of flow of designed system feature values can be extracted from this image.
4. For training and implementation of classifier a 'Nailyzer' [1] dataset of nail images is used and testing of classifier is done with mixed dataset which contains some images from nailyzer dataset which are not in training set and some images of our own nails.
5. 5) After getting all feature values RGB and mean pixel value, it gets feed into SVM trained classifier to make prediction according to features of image.
6. After completion of the prediction part, maintain the record of this data is very important. To deal with this our proposed system used ThingSpeak cloud; an IOT platform to store data. ThingSpeak provides us with 'read API key' and 'write API key' to read the stored data and to put the required data on cloud respectively.
7. To secure the data i.e. the feature values and their corresponding diseases, data is stored in blockchain with its labelled hash id.
8. System admin has access to user report and all other required analysis. Report of patient is available with system admin.

EXPERIMENTATION RESULTS

The results of the compilation of the above algorithm are as follows:

1) Obtaining targeted image (extracted image):

Figure 2: Compiled images



By using the image processing method the extracted image shown is obtained from the original one (input image).

2) Calculation feature values of extracted image:

Calculation of mean pixel is:

Mean pixel= ((total red pixel value/total pixels) + (total green pixel value/total pixels) + (total blue pixel value/ total pixels))/3

The RGB value of image is calculated by masking two of the colours while calculating one of them, this is called channelization of image. Red pixels are considered as first channel, green as the second and blue as third channel.

3) Scatter plot of response classes (diseases): Before training the data it is necessary to find out which features are working out for the model to get maximum accuracy. This can be analysed using scatter plots of data. In scatter plot the graphical view of classes is shown with respect to the features as shown in fig.3, from which we can get an idea, which features separates our classes more broadly. Then features which are not able to classify the data set and trained data with suitable algorithms are left.

Figure 4: Scatter plot of trained data

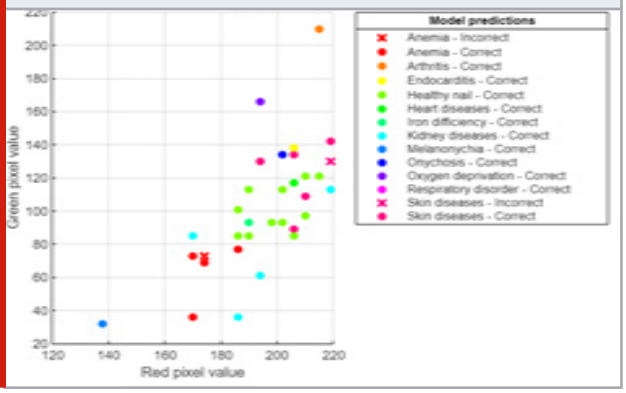
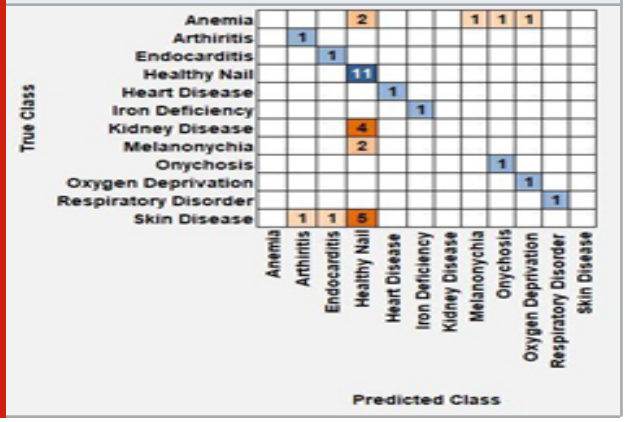


Figure 5: Confusion matrix of trained data



4) Confusion matrix plot: Confusion matrix is used to get analysis of true predicted rates (TPR) and false predicted rates (FPR), blue colour indicate true value predicted and orange or red shows false value predicted. The TPR is the proportion of correctly classified observations per true class. The FPR is the proportion of incorrectly classified observations per true class. In both of the above confusion matrix the number of disease predicted truly is indicted in blue colour and number of disease predicted false is shown in red or orange colour, from this we can calculate the accuracy of prediction of each class also as shown in fig.4 for healthy class the accuracy is 100% and for arthritis is 50%.

Figure 6: Confusion matrix of test data

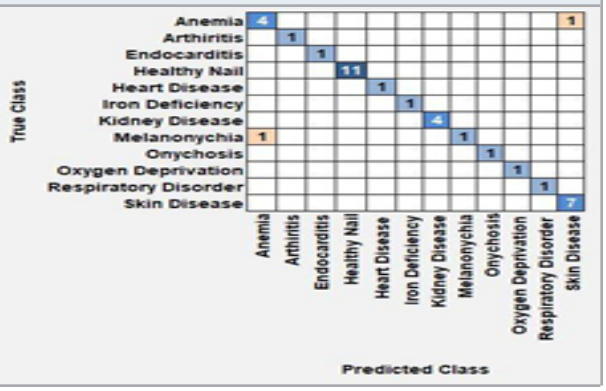
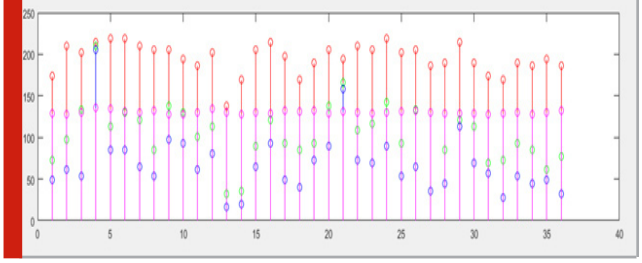


Figure 7: Retrieved data plot from ThingSpeak



5) Showing result of classifier in report format:
Report of the patient

Name of the patient: XYZ
Age of the Patient: XX
Contact No. of the Patient: XXXXXXXXXX
Person might have: 'Skin diseases'

Healthy nail means a person does not have any disease from the predicted class of diseases. In predict function it is very necessary to select prior value distribution. There are two types of prior distribution 1) Empirical 2) Uniform. Empirical probability distribution function is used in this work. Empirical probability uses the number of occurrences of an outcome within a sample set as a basis for determining the probability of outcome.
6) Retrieving data from ThingSpeak using read ID and perform overall analysis of data:

Figure 7 shows the graph between serial no.(of data collection) and its respective feature values, another method of retrieving is tabular which is shown in fig. 11. Serial no. of data entry used as an id for a patient to identify its feature values and disease predicted given in tabular format. Here blue colour represents blue pixel value, red shows red pixel value, green shows green pixel value and pink shows mean pixel value.

7) Securing data using Blockchain concept of hash id: The retrieved data from ThingSpeak is loaded into the Blocks as per entry (i.e. according to serial no.). The blockchain gives each block a unique hash id which is interconnected to each other and data inside is intra

connected. So if someone tries to change the data or change the hash id of the block, the system will throw the warning and the chain will get invalid at the moment. In fig.8 all the data stored in blockchain is valid and chain of blocks is also valid i.e. previous hash id of each block is perfectly linked with current hash id therefore blockchain form is valid and it will give true value at the end. In fig.9 it is shown that if some hacker or unwanted user tries to change the block data then the system will display a warning message and the chain will get broken, this will give false value at the end. In fig.10 it is shown that if a hacker is smart enough to crack the hash id of block and edit the data of block by using the same id, then also the system will give the warning message that the chain form is invalid as the current and previous hash id of next block will not match.

Figure 8: Output of valid blockchain

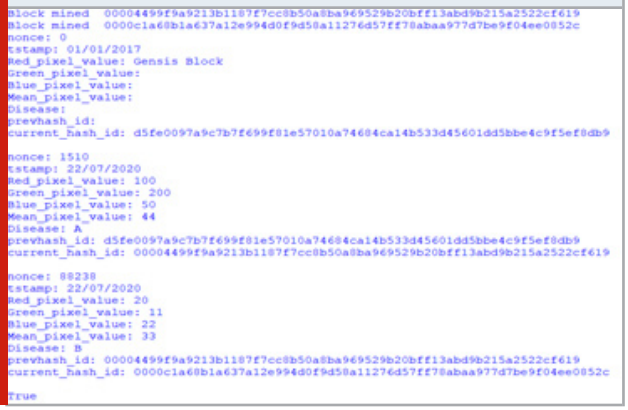
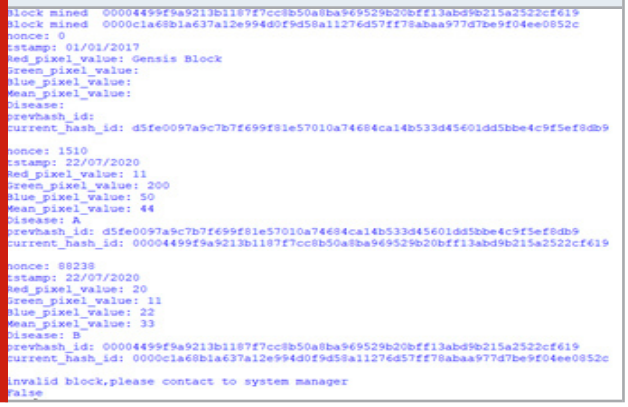


Figure 9: Output of Corrupted block



8) Tabulated form of retrieve data from Thing Speak: The sample dataset retrieved is shown in fig.11. Admin can retrieve data upto required entries, in same single tabular format.

A) Image processing: In the proposed system an input image is taken from the user, then following processes are performed on the image to get the targeted image for feature extraction.

1. HSV image: Used to adjust contrast value of image.

Figure 10: Output of invalid blockchain

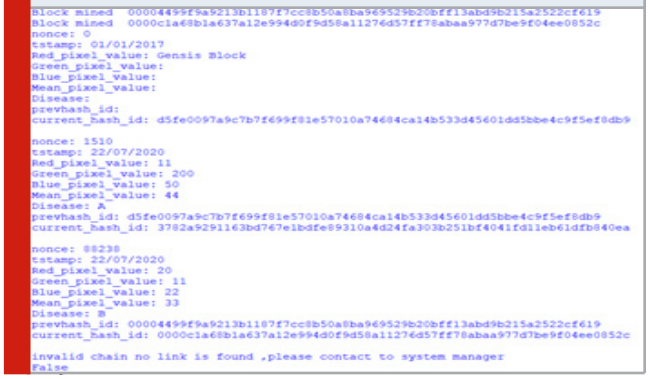


Figure 11: Tabulated form of retrieved data

Sr_no	Red	Green	Blue	Mean_pixel	Diseases
1	174	73	49	128.86	'Melanonychia'
2	210	97	61	128.37	'Healthy nail'
3	202	134	53	130.32	'Onychosis'
4	215	210	206	136.24	'Arthritis'
5	219	113	85	134.19	'Kidney diseases'

2. OTSU image: To differentiate background of image and region of interest of image.[1]
3. Extracted image: To obtain only the image containing the nail part, colour masking technique is used. To make background black in colour masking, RGB values of each pixel of ROI is studied, according to that masking pixel value is decided, if no masking is done then pixel value of background get counted in the mean pixel value and RGB value of image then feature values may get changed and prediction gets wrong.

B) Features Selection: Feature selection is the key step for any prediction model to work accurately. In the proposed model we used first R, G, B channel values [10] of image to classify them in their respective disease class but the accuracy of that model is only about 85% with SVM algorithm used for classification [11]. Then we study the histogram of images in the dataset for future selection of features. In study it is observed that the mean frequency and mean pixel values of nearly each image is different and which can classify the data well into their respective classes. So with R, G, B, features, mean pixel value of image feature is included. Then we get the training accuracy of 95% and testing accuracy of 50% with SVM classifier.

c) Classification Model: The classification model is used to identify the new data on the basis of a trained set of data containing observations whose category class is known to the trained model. The selection of accurate algorithms to classify the data is very important. The features we are choosing and our data set should be compatible with the classification algorithm we are

using for training of our data. In our model we use the support vector machine (SVM) [11] algorithm to train data. SVM tries to make decision boundaries in such a way that the two classes are as wide as possible. This is because our data set contains the features like RGB values, so the minute change in the RGB value changes the shade of image which directly changes the class of disease to which the image belongs [12].

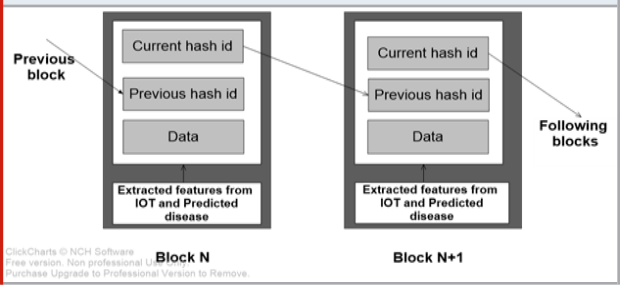
D) Data Management: The proposed system is going to predict the disease on the basis of the input image given by the user and the output is displayed in the software itself. But once the user exits from the system, the display result gets lost. So to overcome this problem we used ThingSpeak cloud to store user data which is an IOT platform. This makes the data available remotely for users. On ThingSpeak cloud we store the feature values of nails as R-G-B and mean pixel value. The ThingSpeak application also features timezone management, read/write API key management. Each channel at this platform is assigned its unique ID called Channel ID. The channel ID and the read/write API key make ThingSpeak a secured IOT platform to store data.

Only a person or organization having channel Id and keys can access the data. ThingSpeak cloud is accessible by MATLAB software. This software provides us with a write and read function as thingSpeakWrite and thingSpeakRead, respectively. Each function comprises the unique channel ID, field number at which data is to be written or read and the respective read/write API key to perform tasks. Data can be retrieved in tabulated form from Thingspeak as shown fig.11. In fig 7 representations of data reading and plotting in the same graphical window with different colour code is shown, where blue colour represents blue pixel value, red shows red pixel value, green shows green pixel value and pink shows mean pixel value.

E) Data confidentiality: Every system which deals with some private data has to take some preventive measures to protect data. As we know IOT has very light shields to protect data therefore we use the emerging concept of blockchain to keep patient personal data secure. A blockchain is a chain of blocks which contain specific information (database), but in a secure and genuine way that is grouped together in a network (peer-to-peer). In other words, blockchain is a combination of computers linked to each other instead of a central server, meaning that the whole network is decentralized. Architecture of blockchain used in system is shown below:

The blockchain architecture contains N number of blocks connected with hash IDs as shown in Fig. 12, the current hash id of Nth block is connected to (N+1)th block's previous hash id. Each block contains the previous hash id, current hash ID and Data, where data contains features extracted from image and corresponding predicted disease. As said earlier the extracted feature values get uploaded on Thingspeak, therefore to make the system integrated and secure we are adding feature values directly from Thingspeak platform to the blockchain.

Figure12: Architecture of Blockchain



CONCLUSION

The system is capable of processing input images given by the user and predict the disease according to feature values of image and providing reports of patients with required entities. As the system is connected to IOT, data can be stored on server and can be accessed remotely whenever needed and due to blockchain usages data remains secured and safe. The data stored on IOT platform can be retrieved using API keys provided by ThingSpeak cloud and analysed whenever the system admin requires. This system requires a little bit of knowledge of software handling and within seconds we are able to predict the disease. If the doctor get acknowledged earlier about a disease through which the patient is suffering or may be going to have some disease it may become easier for them to treat the patient accordingly. The system can be made more user friendly in future. An application can be designed to work on smartphones, tablets or any other smart devices which can give instant report of disease.

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