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Tongue Diagnosis using CNN for Disease Detection

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ABSTRACT- In this modern lifestyle, technologies are helping us to maintain our finances, our household things, shopping, and so on. In our research work, we have proposed an application that would tell you the disease or infection that you may have with the help of the developing technology. In this pandemic period, we have to be safer and more Responsible. We have to avoid visiting public places as much as possible for us and our society. Our main aim is to reduce death rates which are all caused due to finding the disease at its final stage because of hesitation to visit the hospital during this pandemic or because of our carelessness. We can overcome it by checking for diseases or infections frequently using a mobile app. In this research work, we are planning to develop a mobile application using which we can frequently check for diseases or infections since we always have our mobile phones with us. With this application, we can detect the percentage of chance of disease that the user may have through tongue diagnosis by considering changes in various tongue factors. The basic objective of the research work is to make people know about their body condition at an earlier stage more easily and quickly with their smart mobile. In this report, we have included the literature survey made for this proposed system, existing works, software requirements, the proposed system, etc.

Keywords: Disease, Conventional Neural Network, Android, Chinese method, medicine, diagnosis, health checkups.

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1. INTRODUCTION

The core idea of this research work is to make a mobile application for detecting diseases like diabetes, chronic kidney disease, iron deficiency, etc. with tongue diagnosis by analyzing various factors of the tongue. The application is in a way that anyone can use easily with simple steps. Many people in this pandemic are hesitating to visit hospitals for health checkups due to which small curable are getting risky and will lead to dangerous conditions. Not only in this pandemic, but most people also don't have the habit of doing regular health checkups. Though people feel changes in their body condition they are simply ignoring it. For this only we proposed this research work. Though this application does not detect all the diseases that might be in the person's body, this application will help us to detect some. This is one of the Traditional Chinese techniques of analyzing the pattern by analyzing the tongue images and its various features [1]. In this research work, we are trying to do this with the Conventional Neural Network of deep learning techniques that uses a special technique called Convolution. This Conventional Neural Network is mainly used for image classification and to process the pixel data to get more accuracy. The main advantage of this Conventional Neural Network is to detect important features from the image easily without any human supervision. We use the Conventional Neural Network in this research work implementation. In this busy lifestyle with unhealthy food habits and changing sleep patterns, taking care of health is essential. We need to do proper health checks often. To suit this modern and digital era we are proposing this disease detecting mobile application with python programming language with modules like Keras, Numpy, pandas, Matplotlib, shuttle, and learn.

2. LITERATURE REVIEW

In this literature survey, we categorized the existing research works based on the solution given for the diagnosis of various diseases based on tongue features.

2.1 Diabetes Prediction

In [1], the author has introduced a noninvasive diabetes risk prediction model for predicting the risk of pre-diabetics and diabetics, with the help of the type instrument to get the images of the tongue, this is for extracting features such as color and texture, ResNet-50 for extracting the advanced features of the tongue, and finally achieved the fusion. Also, after some testing, it suggests the best performance and best testing performance respectively by considering average CA, average AUROC, average AUPRC, average Precision, average Recall, and average F1 score. They tested the pre-diabetics and diabetics using the GA_XGBT model.

In [2], the author proposed a non-invasive method for detecting Diabetes mellitus (DM) in its earlier stage, it is extracting from the images of the tongue based on the physiognomy. They used feature selection techniques for processing tongue images. The changes that they considered are differences in features of the tongue. Their proposed framework classifies the tongue image as normal or diabetic.
In [3], the author has given a detailed study of the brain, kidney, and diabetic disease. They also surveyed adults who have diabetic disease in China using the ROC Curve.

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In [4], the author made a detailed study on type 2 diabetes mellitus by considering features of patients using the diagnosis system. They considered 9 features of the Tongue. They compared the percentage of coverage of some color features into two groups. *Table 1* shows the summarization of research works on diabetes prediction.

Table 1: Classification of Research Works for Diabetes Prediction

S. no	Title of the paper	Published Year	Description	Publication
01	A tongue features fusion approach to predicting prediabetes and diabetes with machine learning	2021	For reducing the Multiple complications because of progression of diabetics they proposed the model for earlier prediction.	Journal of Biomedical Informatics
02	Early diabetes discovery from tongue images	2020	This paper gives the reason why people are suffering from diabetes. Their proposed system analyzes the tongue image and the result as normal or diabetic.	The Computer Journal
03	Associations between the Neutrophil-to-Lylyllymphocytetee Ratio and Diabetic Complications in Adults with Diabetes: A Cross-Sectional Study	2020	In this paper, the author gave a detailed study of the combination between the level of NLR and the pervasiveness of CVD, DKD, and DR in diabetic affected adults simultaneously.	Journal of Diabetes Research
04	The tongue features are associated with type 2 diabetes mellitus. Medicine	2019	Forgiving problem symptoms of people with diabetes mellitus. They gave a detailed comparison between people of the controlled group and people with diabetes mellitus	Medicine

2.2 Chronic Kidney Disease

In [5], The author analyzed how we can predict CKD (Chronic Kidney Disease) in its earliest stage and concluded that it can be done with J48 with an accuracy of 85. 5%. They established and compared two machine learning algorithms to predict the various stages of CKD. Based on their results, they recommended helping physicians in generating an automatic decision-making system for diagnosing CKD. They said that this study might be useful for building a system for detecting the severity of CKD.

In [6], the author analyzed the prediction of the disease using supervised machine learning classifiers and constructing curves using a mathematical function, by considering some factors. They have applied some python algorithms for each classifier, they noted the results based on non-preprocessing, resampling, and class balancer. The highest accuracy was achieved by the random forest classifier in Smote with resampling with 98. 93 %.

In [7], the author made a detailed analysis of which algorithm is giving high accuracy by taking seven classifier algorithms. They conclude that the highest accuracy of 98. 86% classified the dataset. They also applied a Deep neural network in the dataset they were taken and found that the accuracy of this is 99. 6%.

In [8], the author has proposed a plan to predict the status of diseases. The classification algorithms are shown to result in high accuracy and minimum amount of bias to the attributes. *Table 2* shows the summarization of research works on chronic kidney disease prediction.

Table 2: Classification of Research Works for Chronic Kidney Disease

S NO.	Title of the paper	Published Year	Description	Publication
05	Chronic kidney disease diagnosis using decision tree algorithms	2021	They established and compared two algorithms including J48 and random forest to predict the various stages of CKD and concluded that J48 is better.	BMC nephrology
06	Analysis of Chronic Kidney Disease (CKD) using supervised machine learning classifiers and curve fitting.	2020	They predicted the disease based on level of sugar, aluminum present in the body	International Journal of Advanced Science and Technology
07	Prediction of chronic kidney disease-a machine learning perspective	2021	In this paper, they applied seven classifier algorithms on the paper and concluded that LSVM with penalty L2 is giving the	IEEE Access

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			highest accuracy of 98.86%. They also gave a note that the deep neural networks achieved the highest accuracy of 99.6%.	
08	Chronic Kidney Disease Prediction Using Machine Learning Methods	2020	This paper predicted Disease status based on analytic data, integrated data prepossessing, a missing value handling method	IEEE

2.3 Covid-19 Prediction

In [9], the author had given the analysis of tongue features associated with covid patients. They got the database of COVID-19 symptoms from the Evidence-based Medicine Center of Tianjin University of TCM. The TCM experts analyzed these images to extract various tongue features for analyzing the relationship between tongue features and patients' conditions. They categorized patients into three (mild, moderate, and critical) based on their tongue features. They concluded the study by saying that tongue features have a certain relationship with the category of COVID-19 and that can serve as a potential indicator for the evaluation of a patient's condition and prognosis. *Table 3* shows the summarization of research works on Covid 19.

Table 3: Classification of Research Works for Covid-19 Disease

S NO.	Title of the paper	Published Year	Description	Publication
09	Tongue features of patients with coronavirus disease 2019: a retrospective cross-sectional study	2020	In this paper, they have given the analysis of tongue features associated with covid patients. The images were analyzed by the TCM experts for extracting various tongue features for analyzing the relationship between tongue features and patients' condition. They categorized patients into three (mild, moderate, critical) based on the tongue feature and concluded that covid 19 has a certain relationship with tongue features.	Integrative Medicine Research

2.4 Non-alcoholic Fatty Liver Acid Disease

In [10], the author found the best model for diagnosis which is suitable for large-scale NAFLD screening by constructing different NAFLD diagnostic models, being a great support for the follow-up application of modern imagery technology in disease detection. CNN models were trained using PyTorch and Python frameworks on the Ubuntu system. *Table 4* shows the summarization of research works on Non-alcoholic fatty liver disease prediction.

Table 4: Classification of Research Works for Non-alcoholic Fatty Liver Acid Disease

S NO.	Title of the paper	Published Year	Description	Publication
10	Application of computer tongue image analysis technology in the diagnosis of NAFLD	2021	In this paper, they found the best model for diagnosis which is suitable for large-scale NAFLD screening by constructing different NAFLD diagnostic models, being a great support for the follow-up application of modern imagery technology in disease detection. CNN models trained using PyTorch and Python frameworks on the Ubuntu system.	Computers in Biology and Medicine

3. METHODOLOGY

In this proposed system, we have taken an annotated tongue dataset from Harvard University's official site [11]. To reduce the background noise over the region of the tongue image. All the images were separated and trimmed by ourselves to select the specific area of the tongue and re-dimensioned into 302*264 dimensions. Since the dataset, we have taken contains only images we have taken basic Conventional Neural Network architecture.

In this architecture, to downscale the image dataset and extract the most important features we are using max-pooling which increases the computational cost. In the beginning, we used an activation function called *relu* which replaces the negative in the filtered image with zero, then the activation function called *softmax* which predicts the multinomial probability distribution as our dataset has two class labels. The package *Keras* is the one that plays an important role in this research work. Finally, the deep learning model is ready for deployment. This deep learning model will be deployed into an android studio backend process using java code. The overall workflow construction is represented in *figure 1*. After the completion of the front-end, the whole application will be ready to use by any android users.

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The overall work can be categorized into four different modules as shown below

Module 1 (Requirement gathering)
Collection of the dataset and manual preprocessing

Module 2 (Training and Testing Dataset)
Developing a simple Conventional Neural Network architecture in Google Colab.

Module 3 (DL-based app construction)
Creating a simple camera android application in Android Studio

Module 4 (Deployment)
Deploying. flite module in the application and make some connections to create a complete application.

Finally, Deploy it in the play store.

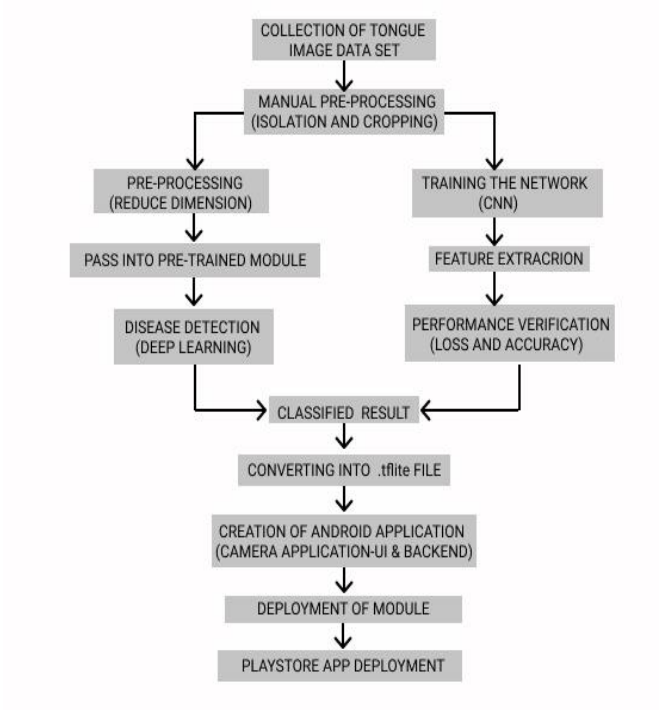

Figure 1: Workflow Diagram

Application working process;
The user will just scan their tongue using a mobile camera. After the process evaluation, the respective report will be generated for the user for disease detection.

4. RESULTS AND DISCUSSION

In this digital era, everything comes into our hands through our mobile phones, most of our daily work can be done through mobile and mobile applications. Like detecting our heartbeat, steps walked with our wristwatch, we can also use this mobile application in a wise way. Anything found and solved in its earlier stage is secure; that's the core idea of this proposed system. This will extremely help the user to prevent high risky stages.

In Harvard University official site [11], we have only 95 images and to reduce the background noise over the region of the tongue image. All the images were separated and trimmed by ourself to select the specific area of the tongue and re-dimensioned into 302*264 dimensions. Refer *figure 2* and *3* for the sample image of our dataset. Our dataset contains iron-deficiency tongue dataset. Basically, this low iron causes a topographical tongue. It results from the loss of papillae on the surface of the tongue. This papillae loss appears as soft glossy, red patches of shapes and sizes variations. This was the main parameter to identify whether the patient has iron deficiency or not. Since the dataset, we have taken, contains only images we have taken of Simple CNN architecture with little modifications for developing this research work. Our parameter configuration for this simple CNN architecture is shown in *table 5*.

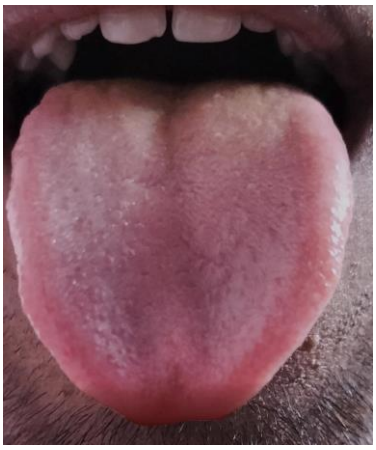

Figure 2: Sample image of Healthy Tongue

Figure 3: Sample image of Iron Deficiency Tongue

After the evolution of the validation generator, we get a loss of 0.6931 and an accuracy of 0.5000 as shown in *table 6*. It shows the result in probability format. We will convert this whole module *into.tflite* (Tensorflow Lite) for the deployment of this deep learning module in android studio to make a better application. Our research work can be implemented with the following configurations such as Intel i7 processor with 8th gen, 8 GB RAM, 2 TB SSD, 2GB AMD Radeon Graphics Card and Windows 11 OS.

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Table 5: Basic CNN Architecture Parameter Configuration

Layer (type)	Output Shape	Parameters
conv2d	(None, 148, 148, 100)	2800
max_pooling2d	(None, 74, 74, 100)	0
conv2d_1	(None, 72, 72, 100)	90100
max_pooling2d_1	(None, 36, 36, 100)	0
flatten rate	(None, 129600)	0
dropout	(None, 129600)	0
dense	(None, 50)	6480050
dense_1	(None, 2)	102

Total parameters: 6,573,052
Trainable parameters: 6,573,052
Non-Trainable parameters: 0
None

Table 6: Overall Output Accuracy

Loss	0.6927110552787781
Accuracy	0.5

Finally, we tested it with a sample disease-affected image, it returned the value 1 and for healthy tongue image, it returned 0.

5. CONCLUSION

As of now we are using a deep learning module that can be deployed into the android studio as a *.tflite* file for launching it as an android application. Currently, we have only an iron deficiency dataset. In future we will increase the current accuracy of 50% by extending the count of our dataset using augmentation techniques and implementing the modified CNN architecture. After the collection of datasets for various diseases and statistical analysis, we will train the module for various diseases to make this application available for detecting various diseases. This android application will help us to uplift our day-to-day health concisely. We also planned to develop this application as platform independent.

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