IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Medibot: End to end voice based AI medical chatbot with a smart watch

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***Abstract*— The percentage of users on the internet searching for health details are increasing significantly. Many reasons urge citizens to use the Internet to check for knowledge regarding Health. Trusted medical details including illnesses, symptoms, and counseling are necessary for people with a certain general illness symptom or for being used as decision-support information before they consult a doctor. "MediBOT" end to end voice-based chatbot introduced to increase the capability of services and to reduce the running expenses for medical consulting services with the help of 4 diverse components: Disease prediction chatbot in Tamil, Prescription Reader to read the handwritten prescriptions, Skin disease predictor to identify your skin diseases and a smart IoT device to read vital signs. The main objective of the work is to provide an idea to people about their wellbeing and give the best protection with four different features in s single application.**

Keywords*— MediBOT, IOT – Internet of things, CNN - Convolutional Neural Networks, SNNET – Simple Neural Network, Image Processing, NLU –Natural Language Understanding, NLP – Natural Language Processing, ML- Machine language*

I. INTRODUCTION

Healthcare sector is one of the areas that widely use artificial intelligence programs to solve problems in recent years. There are large number of studies and research conducted already to find out how to use AI for diagnosis and treatment of diseases. with the use of deep learning techniques such as natural language processing, object detections and image classifications, many applications have been introduced to predict diseases and predict the stage of the diseases, and virtual assistant applications to assist patients. Currently most people tend to be careless about common health problems as well as they do not have enough time to go for a checkup because of their busy work schedule. They took their prescription, follow traditional treatment without consulting a doctor. Therefore, having a system that could give a better understanding of the disease will help people to get an idea about the disease they have. After that, they can further decide to consult a medical expert for treatment if they want to.

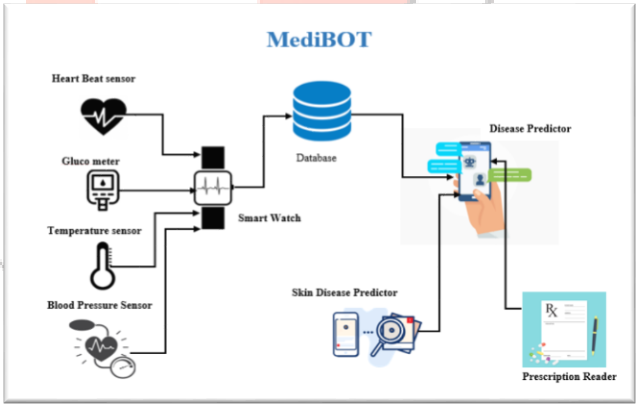

Figure 1: System diagram

Well-developed and sustainable healthcare systems offer better, quicker, effective, and affordable approaches to health problems. These technological developments can lead to a healthier community with healthier individuals. Smartphones and tablets are replacing traditional monitoring and tracking mechanisms and people are offered to having a better medical assessment in comfort and privately at home. A chatbot is a software robot that can interact with the user through automated conversions and allow users to get an answer. Using chatbots, healthcare systems can be developed to assist people in the diagnosis of healthcare problems. Figure 1 shows MediBOTs overall system diagram.

The proposed system, "MediBOT" is a healthcare chatbot that can interact with patients from asking questions about symptoms such as fever level, diarrhea, muscle aches, and coughing to recognize diseases. from these questions, the

system will predict the most applicable disease using a machine learning technique. Prediction occasionally requires vital sign details such as temperature, heartbeat, blood pressure, and glucose level to recognize the disease. Therefore, the system has a smartwatch device with vital sign sensors to get those details. Concerning the skin disease predictor, users should have to upload or capture an image of the affected skin areas to the system. The system will process and analyze the image of the skin and identify what kind of skin disease it is. Given That the doctors use Italian abbreviations to write down prescriptions, ordinary people cannot understand the medications usually. Though, it is beneficial to know about the medications we use. Therefore, the problem can be solved using a prescription describer.

II. Background & Literature review

Our objective is to add more features to the system that the system could operate as a medical assistant to every common people. According to previous researches, it was identified that there are few medical chatbots available with many limitations. The system takes plain text as input and answers for all types of questions for qualified user's output and speech reorganization with an output Using Dialog flow API. The purpose is to provide a generic solution to this problem. [1] But the issue with these chatbots is that they only provide answers for common language English and for a few limited diseases too. We do not know that every user knows English, for that here we selected a specific language to communicate.

This sort of smart interaction (usually utilized in disease counseling) is often achieved by the inclusion of NLU, NLP, and ML techniques within the conventional scripted chatbots. Also, it specifies various NLU, NLP, and ML techniques to be incorporated within the chatbot and therefore the comparison of the same [2] within the literature, chatbots, and conversational agents are often distinguished consistently with their level of understanding of language, the previous using keyword or rule engines instead, until the end they supported machine learning to get high accuracy. The chatbot provides a unique and qualified answer to the user's query. They formulate their queries in natural language via a voice or text interface. The operating model of a chatbot is always the same, whatever its scope, its theme, and it is level. The answer may be generic, contextualized (adapted to the context), or customized [3].

Considering the prescription component, most of the studies are related to usual handwriting recognition but not much for difficult handwriting like the prescription of doctors. Abhishek Bal [4] underlined an off-line handwritten text review for only a cursive handwritten paper via segmentation, skew identification, and writing strain identification. The suggested approach has been evaluated on more than 550 IAM database text images and model handwritten images that are written on a different background by another researcher. Nibaran Das [5] has used a convex hull algorithm to extract features. The tests were carried out in Bangla on a database of simple characters & numbers. The identification report for hand-written Bangla characters is 76.86% and Bangla numerals are 99.45%. A multilayer perceptron (MLPs) was used for classification by Subhadip Basu [6]. The feature set is designed to recognize the complex characters by using three types of topological features, i.e. longest run functions, modified shadow functions, and octant centroid functions. Nafiz Arica [7] suggested segmentation and recognition techniques that are used for offline cursive handwriting recognition. M. Shen [10] proposed a segmentation to detect text characters from a document image using a Vertical Projection Profile. VC Kieu [11] suggested an OCR prediction approach for local blur calculation as blur is also one of the major factors that mostly damages OCR precision.

In the previous studies of skin disease prediction, they are mostly focused on desktop applications to assist dermatologists for skin disease prediction and limited skin disease prediction as well as the dataset used to develop has a limited number of images. the accuracy of the prediction also needs to be improved. Prediction of Skin disease using Data Mining Techniques [12] is a desktop-based system developed to predict skin disease using different classifier methods and compare them. K-means algorithm used for image segmentation to determine affected and non-affected skins and Grey Level Co-occurrence Matrix used for feature extraction. The system developed using three classifiers such as Multi SVM, K-NN, and Naïve Bayesian Classifier. Compare to other models, Multi SVM showed a better performance of the accuracy level of 97%. But here the problem is the dataset used. The system was developed using only 80 images. a large number of image datasets can increase the accuracy. However, the application can tell whether the skin is affected by disease or not. The system cannot output the disease name to the patients. Expert system for diagnosis of skin disease [15] focused on some common skin diseases in Sri Lanka at that time such as impetigo, eczema, and melanoma. The system was developed using OpenCV in C++. MLP, NaiveBayes, Adaboost, and BayesNet were some algorithms used in this model. Diagnosis of skin disease using CNN [16], a model developed using Convolutional Neural Network. However, the problem of this model was the accuracy as it has only 70% accuracy. But with CNN, the system can achieve higher accuracy.

The proposed system overcomes this problem as an android application developed using advanced deep learning method Convolutional Neural Network with a large dataset for common skin diseases in Sri Lanka such as melanoma, eczema, and acne.

Finally, in the smartwatch function, the earlier researches mostly focused on collecting only one vital sign as heart rate data collecting using a smartwatch [17]. In another research [18], they have applied multi-parameter health monitoring as it can calculate the vital signs such as pulse rate, heart rate, and blood pressure. Even though it lacks some signs such as temperature and glucose level in the blood. Therefore, our proposed system can calculate a greater number of vital signs such as temperature, heart rate, and glucose level in the blood. Overall, most of the medical chatbots are limited in their ways. But our MediBOT is a medical chatbot that has many features such as common disease prediction, prescription describer, skin disease predictor, and smartwatch for vital sign calculation.

III. Methodology

The proposed "MediBOT" is an end to end voice-based AI medical chatbot for disease prediction and prescription reader with a smartwatch. That has the capability of,

A. AI chatbot with Disease prediction

B. Prescription Reader

C. Skin disease Prediction

D. Smartwatch (IoT device)

A. AI chatbot with Disease prediction

The proposed system implementing by a defined data set, if the patient input a question, NLP will extract the question to intents and entities. Then it will be searching for the response and give the reply or the solution. This work is performed by analyzing the datasets of which we have trained using an algorithm. Depending on the accuracy and detail of their script; they are also able to identify each patient's individual

complaints and requests and adopt a suitable approach to offering them the assistance they need. This process can be repeated any number of times, and the online chat bots learn and improve with every interaction. Significant technical expertise is required to implement Natural Language Understanding (NLU). In some cases, especially when it comes to gender, the use of buttons may be an alternative for guiding the user towards a precise choice and improving the understanding of the Chabot. The Chatbot then proposes several alternatives from which the user can choose by clicking one [3]. Most of the Chatbots are commonly embedded with the English language for that our system focuses on the Tamil language. It can be used for teaching and as a virtual doctor for awareness and key care.

The machine understands the important elements from the user's input, that should relate to particular features in a data set, and gives an output. The main use of NLP is to recognize the meaning of the text which input by users. The stored information contains the text files, like symptoms related to a particular disease on the basis of which model can predict the disease also some temporary solutions related information.

Disease prediction used SVM (support vector machine) and SNNET (Simple Neural Network) Algorithms which helps to train the model and test. The model was built using Python tools: Pandas, NumPy, and Jupiter Notebook. For each model, we have taken the confusion metrics, classification report, and accuracy to predict the best model for future prediction. A large set of data has been considered and undertaken some preprocessing initialization.

```
SVC(C=0.18, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
 kernel='rbf', max_iter=-1, probability=False, random_state=None,
shrinking=True, tol=0.001, verbose=False)
        [[ 0  0  0 ...  0  0  0]
         [ 0  0  0 ...  0  0  0]
         [ 0  0  0 ...  0  0  0]
         ...
         [ 0  0  0 ... 21  0  0]
         [ 0  0  0 ...  0  0  0]
         [ 0  0  0 ...  0  0  0]]
```

Figure 2: SVM Classifier

In the SVM classifier (Figure 2), we used a hyperplane to tune the hyperparameter/regularization parameter which is known as C solve the optimization problem in the model. SVM has the best feature space size, So that performance also increases for small or medium sizes. In SNN classifier (Figure 3) we used alpha to tune the accuracy level. SNN is faster to train with respect to the best feature space train themselves to recognize patterns finding in the data, and then predict the output for a new set of similar data. Existing Chatbots are commonly have some limited disease prediction, for that we trained a model with unlimited diseases. By using SVM and SNNET algorithms, the system can predict all kinds of diseases. Users can get related answers displayed on the android app and refer this answer for analysis.

```
NN_model = MLPClassifier(alpha=0.001, max_iter=1000)
NN_model.fit(train_features, train_labels)

NN_predict = NN_model.predict(value_features)

print(confusion_matrix(value_labels,NN_predict))
print(classification_report(value_labels,NN_predict))
print(accuracy_score(value_labels, NN_predict))
```

Figure 3: SNN classifier

B. Prescription Reader

Since the system requires identification of the written prescription, the core idea of the process is the recognition of images. The approach consists of two main parts, which are image processing and the other, deep learning. Deep learning methods today play a key role in character identification. Developing neural networks has helped Deep learning to deliver better results.

1. Preprocessing: The input image must first proceed through pre-processing before reaching Convolutional Neural Network. Preprocessing the image of the sample requires a few steps which are described as follows:

- **Grey scaling the input image:** Method of transforming a colored image into a black and white image.
- **Binarization:** Binarizing an image turns it into an image that has pure black and pure white pixel values in it.
- **Inversion:** Inversion is a mechanism where each pixel of the image gets a color that is the previous one's inverted color. This procedure is the most essential since every character on an image taken could only be efficiently extracted if it only contains one color that is distinct from the background color. Note that this is only needed if the artifacts that we will define on a lighter background are of darker severity.

2. Segmentation: The image is subjected to pre-processing for background noise removal after scanning the document, and binarization to produce the text's bit map file. The image pre-processed is subdivided into lines, words and characters. Explanation is given in the following.

- Line segmentation- The line segmentation is used to separate lines of text.
- Word segmentation- Segmentation of Words provides space between phrases.

3. Feature Extraction: In this phase, features of individual character will be extracted. The performance of each character recognition system that depends on the features that are extracted. The extracted features from the input image should allow the classification of a character in a unique way. CNN has many layers in which some layers obtain from the images the necessary parameters/features to classify them so that the manual extraction feature is not required.

4. Creating an Artificial Neural Network: CNN typically consists of three layer.Those are convolution layer, sub-sampling layer, and a layer of full relation. Based on the requirement we can add the SoftMax layer. Differences in identifiable handwriting language often influence how many layers are potentially added on CNN. When the SoftMax layer is introduced into CNN the precision of the handwriting recognition is high.

5. Training & testing the network : Train the model created by the database of the Institut für Informatik und Angewandte Mathematik (IAM) includes types of English manuscripts, which can be viewed as a basic base because it has good accuracy for the identification of texts. However, it carries with it the difficulty of making many authors, that is, the cursive style is unregulated.

C. Skin disease predictor

Since the application needs to diagnose the skin disease through the images of affected skin lesions, the main concept of the system is image classification. The process consists of two main parts, one is image processing and the other one is deep learning.

Dataset: The dataset is categorized into three different kinds of skin diseases such as melanoma, eczema, and acne with more than thousands of images. The system needed to take camera images for prediction, Image dataset collected from the camera is used to build the model. This dataset is collected from the dermNet.org website and some other dermatology related websites.

Data pre-processing: The collected dataset contained images which are not same size, and some images were complex to be feed into a deep learning model. The accuracy of the skin disease prediction will be affected by those imbalances and the system may give wrong predictions. Therefore, the images are changed to a common pixel rate. The image has converted from RGB (Red Green Blue) to Greyscale to improve the quality of the image for better performance.

Feature Extraction: The purpose of this step is to extract useful and appropriate features of the affected disease region which could be used to identify the particular diseases. Those features are color features, shape features and texture features.CNN has many layers that some layers obtain the needed parameters/features from the images to classify them into classes, so the manual feature extraction is not needed.

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_9 (Conv2D)            (None, 248, 248, 64)      640
_________________________________________________________________
activation_12 (Activation)   (None, 248, 248, 64)      0
_________________________________________________________________
max_pooling2d_9 (MaxPooling2 (None, 124, 124, 64)      0
_________________________________________________________________
conv2d_10 (Conv2D)           (None, 122, 122, 64)      36928
_________________________________________________________________
activation_13 (Activation)   (None, 122, 122, 64)      0
_________________________________________________________________
max_pooling2d_10 (MaxPooling (None, 61, 61, 64)        0
_________________________________________________________________
conv2d_11 (Conv2D)           (None, 59, 59, 64)        36928
_________________________________________________________________
activation_14 (Activation)   (None, 59, 59, 64)        0
_________________________________________________________________
max_pooling2d_11 (MaxPooling (None, 29, 29, 64)        0
_________________________________________________________________
flatten_3 (Flatten)          (None, 53824)             0
_________________________________________________________________
dense_3 (Dense)              (None, 3)                 161475
_________________________________________________________________
activation_15 (Activation)   (None, 3)                 0
=================================================================
Total params: 235,971
Trainable params: 235,971
Non-trainable params: 0
```

Figure 4: CNN Layers in skin disease model

Classification: Afterimage processing and feature extraction, the images classified into one of the pre-defined diseases using the CNN algorithm. The fully connected layer is actually the final layer where the actual classification happens. CNN consists of multiple layers like a convolutional layer, a pooling layer, and a fully connected layer.

Android Application Deployment: The trained model will be deployed into an android application to predict the skin disease using uploaded images from mobile camera.

The algorithm used: Convolutional Neural Network (CNN)
In image classification, CNN takes images as input and uses filters/neurons to extract the necessary feature from the images and classify them into certain categories. CNN has multiple layers such as convolutional layer, pooling layer, and fully connected layer. Technically the image will be gone through these layers and will be classified into a particular class. Figure 4 explains the CNN layers used in Skin disease model.

```
[ERR:3] "write" -> "iits"
[ERR:4] "Wtulo" -> "Notl"
Character error rate: 18.865806%. Word accuracy: 62.448276%.
Character error rate not improved
No more improvement since 15 epochs. Training stopped.
```

D. Smartwatch (IoT device)

Through firebase, the real-time data will be analyzed and create a trained model along with python using SVM, a simple neural network, and predict the disease according to the symptoms from the user input and the fetched sensor data. Hereafter the implementing design process, the Analog to Digital Converter (ADC) will gather the data from the wearable sensors which are heartbeat sensor, temperature sensor, and glucose meter where that pushes the reading data to the raspberry pi board.

Next, the heartbeat and temperature sensor's power pins are connected to that board and connected to their ground (GND) pins on the board. In a detailed view, the raspberry pi 4 has no analog pins, but the heartbeat, temperature sensors are work with the analog pins only. Arduino Uno's pin no 0 (analog pin for reading output) will relate to the heartbeat sensor's analog pin. For power supply purpose in the raspberry pi 4 board, we will provide the power with a 5V, 2A electricity through a power bank.

The accessing of the raspberry pi board, first we need to install the Raspbian Operating System (OS), which will prompt us a Graphical User Interface (GUI and windows connection application (VNC viewer). Here the purpose of this GUI is code in python IDE to fetching the data from Arduino Uno serially and get the reading data from a glucose meter. In the Arduino IDE using the period, the created business logic will be uploaded in the Arduino Uno. Now the Arduino Uno will send the gathered real-time data to raspberry pi4 from the wearable sensors. In the Raspbian OS python IDE, also we create the code in the python programming language to send the data to the firebase Real-time database with the use of firebase APIs. After the data storage process, we will get real-time data from the firebase and analyze it from creating a model. For that, here we use Support Vector Machine (SVM) and Simple Neural Network (SNNET) algorithms which help to train the model. Using these algorithms along with the data of the symptoms and the sensor data the pre-trained model will predict the related disease and display it to the user in the android Chatbot application.

IV. Results and Discussion

The proposed system is an Android App that has a chatbot integrated with it Dialog flow API Embedded with disease prediction, Skin disease prediction, prescription reader and an IOT device. The chat-bot has been employed within a medical decision support system having the goal of providing useful recommendations concerning several disease prevention ways. chatbot systems are available in the world were not satisfying the customer expectation and not up to a level where the implementation made in medical sector. This chat bot satisfied customer problem, language barrier and unlimited disease prediction. There for, text to text and voice text response will available. This component is developed using SVM and SNNET. The chatbot has Tamil language access which can limit the language barrier of users and the disease prediction model has more than 50% prediction accuracy that should be improved in coming days. The chatbot will ask some questions regarding the symptoms of health issues and the model will analyze the responses from the user and give the correct disease prediction as result.

Figure 6: Accuracy level of prescription model

Doctor prescriptions can be read by a pharmacist or another doctor due to a unique handwriting style of

them, which means an ordinary person cannot read the prescription. Prescription reader includes Handwriting recognition and it convert the recognize file into downloadable format. All of that it will give a reminder to user to take care of the drugs. component is prescription reader that can analyze the image of the handwritten prescription uploaded by the user and display the prescription in a readable format and user can download the prescription also. The training accuracy of the model is around 62.44% with more than 2000 image data and the validation error rate around 18.86% and this must be improved further (Figure 6)

Skin disease is a common health issue that affects more people. But with advancement of technology how a common person can get diagnosis of dermatology without consulting dermatologist. The trained model has three skin disease classes such as Melanoma, Acne and Eczema. The training accuracy of the model is around 95% with more than 2000 image data and the validation/testing accuracy of the model is around 69% and this must be improved (Figure 7)

For the testing purpose, images collected from different other resources also tested and the predictions were almost correct as per the model accuracy. The accuracy and number of diseases will be improved further.

```
Epoch 13/20
2030/2030 [==============================] - 336s 166ms/sample - loss: 0.1967 - acc: 0.9276 - val_loss: 1.3015 - val_acc: 0.690
9
Epoch 14/20
2030/2030 [==============================] - 297s 146ms/sample - loss: 0.1883 - acc: 0.9325 - val_loss: 1.4531 - val_acc: 0.637
8
Epoch 15/20
2030/2030 [==============================] - 303s 149ms/sample - loss: 0.1885 - acc: 0.9374 - val_loss: 1.5655 - val_acc: 0.673
2
Epoch 16/20
2030/2030 [==============================] - 715s 352ms/sample - loss: 0.2010 - acc: 0.9246 - val_loss: 1.5757 - val_acc: 0.653
5
Epoch 17/20
2030/2030 [==============================] - 1047s 516ms/sample - loss: 0.1563 - acc: 0.9498 - val_loss: 1.7642 - val_acc: 0.67
72
```

Figure 7: Accuracy level of skin disease predictor model

Increases of the heart diseases, here implemented system prototype uses raspberry pi that is driven by Internet of Things (IoT) connected through different sensors. Fetch all the sensors reading and send the data to the firebase real-time database. Get the data from the database for analyze and predict the disease. Another component is smart device to collect vital sign details of the user to the disease prediction. The IOT device have sensors such as heartbeat sensor, temperature sensor, and glucose meter each can collect the related vital sign details and send the data to analyze and predict the disease.

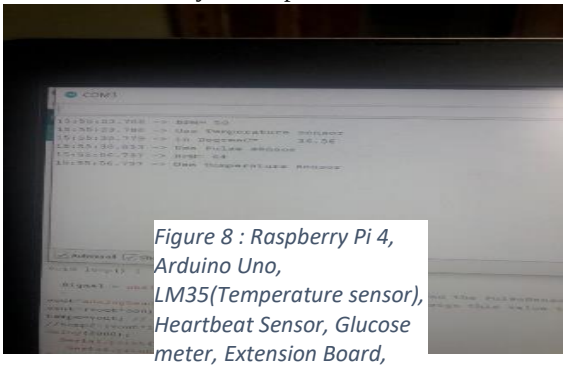

Figure 8 : Raspberry Pi 4, Arduino Uno, LM35(Temperature sensor), Heartbeat Sensor, Glucose meter, Extension Board, Power Bank, Jumper Wires

Outcome of this paper is fully embedded chat bot call MediBOT. full of the system give an accurate voice recognition with Tamil based chatbot with unlimited diseases prediction , more accurate engine to recognize the handwritten prescription , can predict the skin disease from affected skin images of 90% accuracy, and Smart device with reading data. And it's an android app where user can give input and get output.

V. CONCLUTION AND FUTURE DEMONSTARTION

Health is the biggest worldwide problem for humanity. Over the last decade, healthcare has drawn a significant amount of attention. "Artificial intelligence-based medical chatbot named MediBOT" has been implemented as planned, with some slight changes that suited the current medical and technical specifications and time constraints.

Traditionally, there was no such design or method which could be used in the mobile application for symptoms related disease prediction and advanced with smartwatch, readable format prescription reader and skin-related disease identification. This system eases the lifestyle of the modern world peoples. Language control has been a major drawback of the pre researchers build applications. To eliminate that shortcoming in our research. We have first developed a chatbot in the Tamil language. Thereafter, we have tried to incorporate the Sinhala language in our upcoming updates of the application.

In the future work, In a real-world scenario implementation, it would probably be an innovative idea, if we add another local language like Sinhala and after that developed in many international languages. Now this research has only the four main features itself. In the future additionally, connect with many more features such as medical and people needs related. Another major future work-related this research is developed this mobile application in the IOS platform and release it in the App store.

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Figure 9:Real time vital signs reading

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