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An E-Health Patient Management System

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***Abstract*— In today's world healthcare is the core area of the medical domain. A system providing healthcare services online is a necessity since an increasing number of patients are trying to access healthcare online. This paper provides the solution focusing on making the health care sector online. The system provide insights concerning connecting to doctors remotely and providing identification and treatment online and describes prediction of various diseases and using a web-app as a front end to store data on a database.Patient's voice would be used as an input to our system recording the symptoms they are having and those will be stored on a database. Natural language processing (NLP) would then gather needed symptoms and send them to the doctors. Then the system will predict the exact disease the patient may have using the random forest(RF) algorithm.Random forest gives the best accuracy amongst other algorithms i.e. almost 93.55%.**

***Index Terms*— Natural Language Processing, Speech recognition, random forest, Mel Frequency Cepstral Coefficient.**

I. INTRODUCTION

Speech recognition has many and wide range of applications. Every sector is getting digitized-health offers many benefits such as time savings, access to the history of each patient with more security. Today, 47% of the speech recognition technologies introduced on the market are taken up by voice-based applications for the healthcare industry.It is possible that speech recognition will take over as the patient experience service's primary technology.Because of the shape our data is in, we do not yet make optimal healthcare decisions by analytics. There is also a stronger need, as we want value-based health care, to operate on this unstructured data.
This is where the processing of natural languages comes in. NLP based chat-bots already possess the capabilities of well and truly observing human behaviour and executing tasks. When it comes to implementing larger use cases, like a hospital – it can be used to parse information and extract critical data, offering an opportunity for us to work on unstructured data. Therefore we need a more efficient system for doctor patient virtual interaction with the help of speech recognition. So, our system will provide a platform for patients to connect to doctors virtually and get themselves diagnosed and get medicines prescribed.

II. LITERATURE SURVEY

This chapter provides an overview of research done on current systems and technologies used in the healthcare sector.In the paper [1] They addressed mechanisms of speech recognition that would be available to speakers who suffer from dysarthria. There are seven features derived by the author from noiseless speech signals in

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English and Tamil language[2] An android application that keeps track of user health records was developed by the author, which takes input through voice recognition. It stores recorded key data on the cloud. In paper [3] they highlighted the potential of healthcare speech technology and also addressed difficulties and risks for the healthcare industry in speech.. Author talked about the importance of e-prescription and avoiding problems with hand written prescriptions. They have created a voice based prescription system to create an e-prescription which also provides access to the patient's medical records at real-time in paper [4].In paper [5] In order to include signs of psychiatric disorders, they addressed the text medical record retrieval model mistreatment linguistic communication mechanism (NLP) referred to. In order to better diagnose the types of psychiatric illnesses and their treatment, this model may be part of the case-based rationale ADP scheme. Paper [6] provides a summary of a projected system to extract text from scanned medical prescription, then linguistic communication process and machine learning techniques are accustomed to give effective classification exploiting embedded terms and classes concerning patient/doctor personal knowledge, symptoms, pathology, designation and instructed treatments.

III. Motivation

Motivation behind developing this type of system was the whole recent covid situation where we have to follow lockdown and social distancing.We can overcome shortage of medical resources with the incresed efficiency .Using voice based assistants in this system we can maintain records and history which is very useful for future treatment of that particular patient.

IV. Problem Domain - Machine Learning

V. Problem Definition

The System should provide a facility for patients to record their symptoms in it and send those to the doctor. The doctor will get symptoms in text as well as audio format and he will dictate the prescription to the system and it will convert it in text format and send it to the patient. The doctor will also get recommendations for prescribing medicines. Finally, the records will be stored online for both doctors and patients to access at any time.The system is currently limited only to english language.

VI. Statement

A virtual patient management system where speech recognition and disease prediction module is used for efficient treatment of patient

VII. System Design

This figure(1) shows the architecture of the system where initially we have a speech recognition module which is used to convert recorded audio into text followed by a Natural Language Processing module which is used to extract information from the text. This information is used for disease prediction using random forest algorithm.

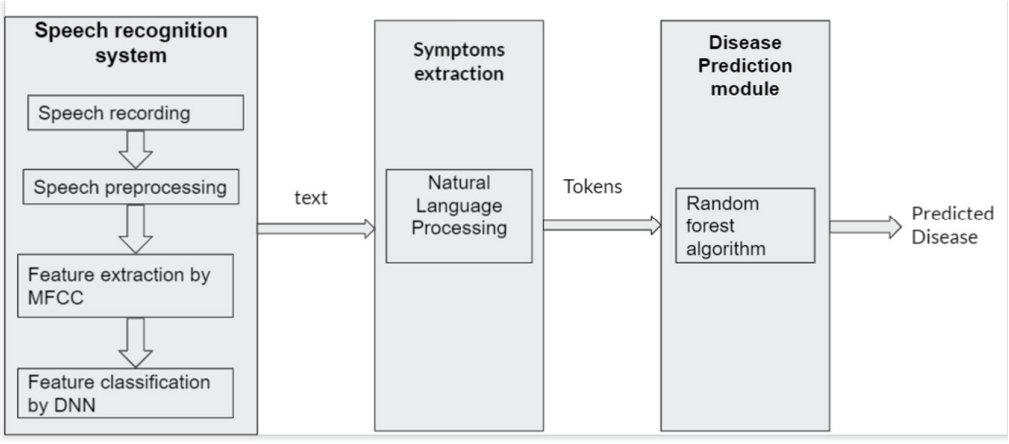


fig (1) System design

VIII. SOLUTION METHODOLOGIES

A. Mel frequency Cepstral Coefficients (MFCC)

By converting the conventional frequency to the Mel Scale, MFCC takes human experience of sensitivity at appropriate frequencies into consideration. The features such as strength, the arrangement of pitch and vocal tract present in the speech signal are defined by these coefficients. It is the best method of extraction function that offers the highest precision.Once the speech is recorded and any additional noise is removed from the speech file to extract features from the speech file we apply framing and windowing to it, then we perform full Fourier transform on the windowed signal. These signals are then passed through a Mel Filter bank. Finally we take log and perform Discrete Fourier Transform on the signals.

B. Natural Language Processing

Text mining is a form of artificial intelligence that employs natural language processing to convert unstructured text into normalized, structured data that can be analyzed or used for machine learning algorithms.
Steps involved in Natural Language Processing with example:
Input for Natural Language Processing is text received from speech to text.
For example the text from speech to text is “I have been coughing since yesterday and I have back pain and fever. My body temperature is 104 and I also feel nauseous ” applying the following steps on text.
Step 1: Segmentation of sentences
Text broken down into sentences :-
['I have been coughing since yesterday', 'and I have back pain and fever my body temperature', 'is 104 also have feeling nauseous']
Step 2: Tokenization by word
Break down sentences into tokens :-
[['I', 'have', 'been', 'coughing', 'since', 'yesterday'], ['and', 'I', 'have', 'back', 'pain', 'and', 'fever', 'my', 'body', 'temperature'], ['is', '104', 'also', 'have', 'feeling', 'nauseous']]
Step 3: Finding part of speech of each Token
Finding pos tags:-
{'I': 'PRP', 'have': 'VB', 'been': 'VBN', 'coughing': 'VBG', 'since': 'IN', 'yesterday': 'NN', 'and': 'CC', 'back': 'RB', 'pain': 'NN', 'fever': 'NN', 'my': 'PRP$', 'body': 'NN', 'temperature': 'NN', 'is': 'VBZ', '104': 'CD', 'also': 'RB', 'feeling': 'VBG', 'nauseous': 'JJ'}
Step 4: Perform lemmatization of the Texts
In this step we bring token to its basic lemma
Text lemmatization:-
been be
coughing cough
feeling feel
Step 5: Removing stop words
In this step we remove the stop words (words which do not add much value to the text)
[['cough', 'yesterday'], ['back', 'pain', 'fever', 'body', 'temperature'], ['104', 'feel', 'nauseous']]

C. Prediction Model

In our prediction module we have predicted the disease based on the symptoms extracted from speech keyword extraction.We implemented decision tree,naive bayes and random forest algorithm for prediction from which we found out random forest gives highest accuracy of 93.55% and results for the prediction.Input dataset has 4920 rows and 18 columns.We have to give at least one symptom to get the disease predicted.

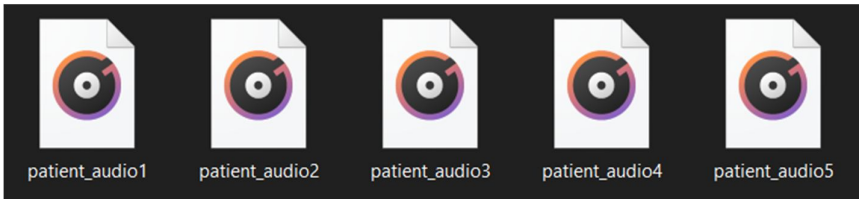
D. Dataset Description

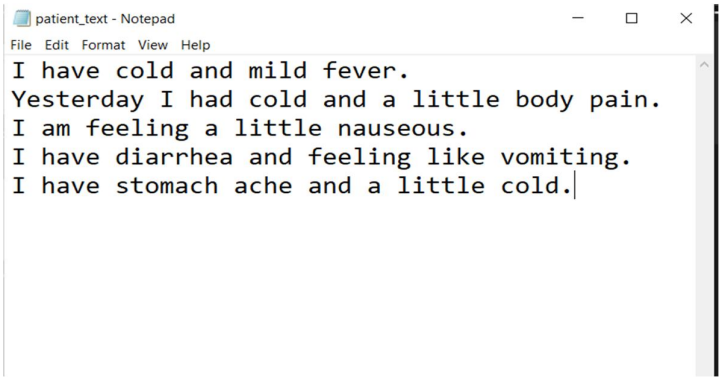
1. dataset.csv contains the 41 unique diseases with their varying symptoms according to various patient scenarios.
2.symptom_desc .csv contains description of 41 unique diseases
3.symptom_precaution.csv contains precautions to be taken for 41 unique diseases
4.Medicines.csv contains medicines for each unique disease.

IX. Justification of the Results

A. Speech Recording and Conversion to Text (Speech Processing)

1. Record audio from patient
2. Save it as .wav file
3. Read that .wav file
4. Convert the audio from that file to text using MFCC
5. Display the text





B. Natural Language Processing:

Step 1: Segmentation of sentences
Step 2: Tokenization by word

```
You said:-- hello doctor I have been coughing since yesterday and I have back pain
and having fever my body temperature is 104 also I am feeling nauseous


Text broken down into sentences :--

['hello doctor I have been coughing since yesterday', 'and I have back pain and
having fever my body temperature is 104', 'also I am feeling nauseous']


Break down sentences into tokens :--

[['hello', 'doctor', 'I', 'have', 'been', 'coughing', 'since', 'yesterday'],
['and', 'I', 'have', 'back', 'pain', 'and', 'having', 'fever', 'my', 'body',
'temperature', 'is', '104'], ['also', 'I', 'am', 'feeling', 'nauseous']]
```

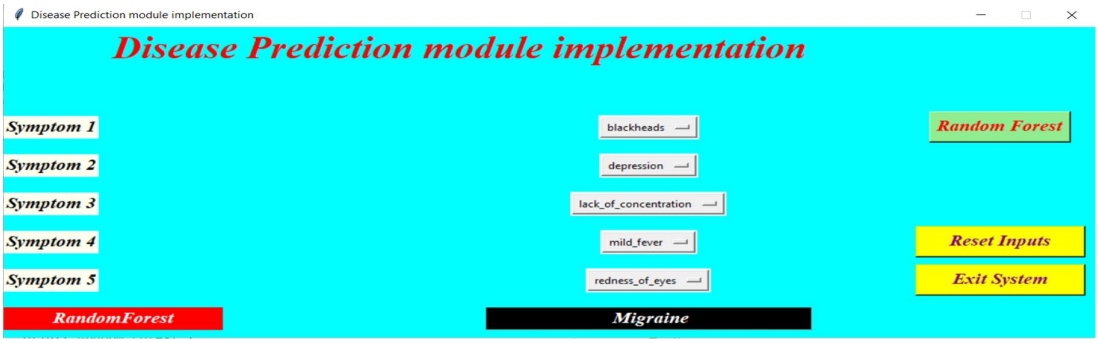
Step 3: Finding part of speech of each Token
Step 4: Perform lemmatization of the Texts
Step 5: Finding stop words
Step 6: Analyzing the grammatical structure of sentences using dependency parse tree
Step 7: Searching for noun phrases
Step 8: Recognizing named entities
Step 9: Finding all expressions that refer to the same entity within the text through coreference resolution

```
Finding pos tags:--

{'hello': 'NN', 'doctor': 'NN', 'I': 'PRP', 'have': 'VB', 'been': 'VBN', 'coughing': 'VBG', 'since': 'IN',
'yesterday': 'NN', 'and': 'CC', 'back': 'RB', 'pain': 'NN', 'having': 'VBG', 'fever': 'NN', 'my': 'PRP$',
'body': 'NN', 'temperature': 'NN', 'is': 'VBZ', '104': 'CD', 'also': 'RB', 'am': 'VBP', 'feeling': 'VBG',
'nauseous': 'JJ'}


Lemmatized tokens

hello                   hello
doctor                  doctor
I                       I
have                    have
been                    be
coughing                        cough
since                   since
yesterday                       yesterday
and                     and
I                       I
have                    have
back                    back
pain                    pain
and                     and
having                  have
fever                   fever
my                      my
body                    body
temperature                     temperature
is                      be
104                     104
also                    also
```

```
[['doctor', 'cough', 'yesterday'], ['back', 'pain', 'fever', 'body', 'temperature',
'104'], ['feel', 'nauseous']]
```

C. Dataset cleaning and Disease prediction model

1. Dataset contains 4920 rows and 18 columns.
2. Checked NULL and NaN values.
3. Removed the trailing space from the symptom column.
4. Filled NaN values with 0.
5. Non Numeric values were converted into numeric values by one hot encoding.
6. On this dataset we have applied a random forest algorithm to get the prediction from symptoms.



X. Conclusion and Future Work

The “E-HEALTH PATIENT MANAGEMENT SYSTEM” is a step towards bringing digitization in the healthcare sector.Voice based application discussed in this paper allows patients to virtually connect with doctor.Architecture of this system is based on the Speech recognition ,Natural Language Processing and disease prediction system.By using the text format obtained from speech recognition we will be extracting symptoms of the patient by Natural Language Processing. Development is mainly concentrated on Natural Language.Processing .Next module will be predicting the disease of the patient using random forest algorithm which gives accuracy of 93.55% .Input dataset has 4920 rows and 18 columns of 41 unique diseases with their varying symptoms according to various patient scenarios.

The future direction for this project will be a medicine recommendation system based on the disease predicted and also storing electronic medical records to access patients history anytime.In future speech recognition models can be exposed to multiple local languages.

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