Digital Doc A Voice-Based Disease Prediction System

Dr. Khalid Nazim Abdul Sattar [1,*], Ahsan Ahmed [2], Dr. Mutasim Al Sadig [3]

k.sattar@mu.edu.sa *, a.ahmed@mu.edu.sa, mm.elkir@mu.edu.sa

[1,3] Assistant Professor, Department of CSI, College of Science, Majmaah University, Al Majmaah 11952, Saudi Arabia,

[2] Lecturer, Department of Information Technology, College of Computer and Information Sciences, Majmaah University, Al-Majmaah- 11952, Saudi Arabia.

Correspondence: k.sattar@mu.edu.sa

ORCID: 0000-0002-0759-0512 [1,*], 0000-0002-0513-3393 [2], 0000-0002-5614-4527 [3]

Summary

In this paper, a voice-based disease prediction system, has been developed to extract symptoms, status, and possible treatments by assessing performance on common symptoms. The designed system uses a decision tree algorithm for prediction of disease based on the patient symptoms. The outcome of the research is focused to blend in with the traditional methods to the machine learning model in a way that works in converting patient speech to text in the application and to describe the most basic class of inspection in medication. In addition, the proposed methodology is limited to run on only voice samples provided and the model as designed can be extended to introduce more robust version to support the users offering natural language interface and connecting the users to specialists in the field of concern.

Key words:

Speech-to-text; Meta-algorithm; Machine learning model; Medical chatbot; Naïve Bayes; Convolutional Neural Networks.

1. Introduction

In the present arena, there has been a lot of contribution from the field of data Analysis in healthcare research[20][21]. For several diseases, medical practitioners have conducted veritable surveys and have gathered information related to common diseases with typical symptoms.

Accurate prediction of diseases based on preliminary symptoms gets difficult even for doctors. Data mining has a lot to offer to the prediction of diseases. It has become necessary to analyze and predict trends with the rise of big data. Using the large amount of medical data over the years, information patterns can be found and can be applied for training and analysis of diseases. Machine Learning has been applied in every other major industry for performing many functions that were unheard [9] [12] [13] [16] [18].

Voice is the most basic and the most basic way of communication for people. Today speech technologies provide very valuable services by enabling machines to respond to human voices reliably.

As speaking is much faster than using keyboard, a speech-to-text voice recognition system which allows the computer to translate voice into text can be developed. Here, this technology has been used to take the symptoms of the patient [5] [6] [8] [16].

In this paper, an online disease prediction system has been developed by using Voice recognition system, Keyword extraction techniques and finally an algorithm has been devised to predict the patient's disease based on symptoms and other details that suggest online immediate treatment [3] [4].

1.1 *Motivation*

Many studies have been carried out on online disease prediction systems. These studies involve various Machine Learning algorithms and a variety of technologies. People have worked on algorithms like Decision Tree, Naïve Bayes, Convolutional Neural Networks for prediction of certain diseases. Developments in technologies like voice recognition systems have reduced the difficulty of communication between humans and machines. Hence, using similar methods and building an online healthcare service not only increases efficiency of prediction, but also provides a system with high availability and greater usability.

People often feel reluctant to visit the hospital for minor symptoms. In many cases, these minor symptoms are the beginning of major health problems. In such cases, online medical help is faster and easily available compared to long rides to hospitals [9] [14].

Manuscript received January 5, 2022
Manuscript revised January 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.1.52

1.2 *Objective*

Generally, people do not express their symptoms in technical terms. This increases the complexity in developing prediction systems.

The objective of this paper, "Digital Doctor- A voice-based disease prediction system" is to build an online healthcare service where the process of recognizing the patient's issue is automated by taking the symptoms of the patient as input and predicting the disease based on the extracted keywords and recommending quick and immediate treatments.

Structure of the Paper

The rest of the paper is as organized as follows, Section II proceeds with literature survey and findings, proposed system is discussed in Section III, Methodology is presented in section IV. The implementation details using Google Speech to Text Conversion API is discussed along with the pseudocode under section V , experimental results are shown in section VI. Finally, the conclusion and future work are followed in sections VII and VIII.

2. Literature Survey

In the present era in addition to the healthcare, educational institutions and large companies are contributing to large amounts of data that help in assessing the importance and need of data to make important decisions.

2.1 *An overview*

Based on the geographical analysis on the Indian population as of 2018, its observed that majority of the population has been affected with the seasonal ailments leading to 70% of the total count followed by mortality rate of 25% due to ignoring the symptoms of early general diseases and this has been a prime concern to identify the disease at early stages and to initiate appropriate course of action.

With the advent of the internet technology, presently the users at ease can get all the information as stored in the web repository. As majority of the human communication is speech based, Computers play a vital role as intermediate for human experts when they are enabled to respond to human voices accurately.

In this context a speech recognition system has been designed that allows a data processor to identify the human interaction using a microphone and converts them into written text.

2.2 *Existing Systems*

Data mining and ID3 decision tree algorithms [17] has been used on the dataset comprising of 120 patient records and obtained an accuracy of 86.67 % to help the users in the prediction for the general and more commonly occurring diseases that when unchecked can turn into harmful health hazards.

An efficient system was developed [18], using a Machine Learning i.e., Decision Tree and new convolutional neural network based unimodal disease risk prediction (CNN-UDRP) for structured data and multimodal disease risk prediction (CNN-MDRP) algorithm using structured and unstructured data. The devised system helped the users to post their queries and get answers related to the query posted and associated symptoms.

In [11], the authors have designed a system that uses MFCC and VQ techniques, which will enable the computer to translate voice requests and dictations, it was also concluded that home automation soon will be voice recognition system based. The major contribution of their work was towards developing a voice recognition system using feature extraction technique, in addition speech recognition approach on a particular language was compared efficiently[20].

Several techniques as applicable in text mining for keyword and keyphrase extraction has been listed in [10], the survey further focused to list the works for keyword extraction in chronological order based on supervised, unsupervised, semi-supervised and statistical approaches.

Use of machine learning algorithms to support disease diagnosis that can be detected by the Doctor and patient on entering the symptoms into the system are discussed [7][19], the authors have also concluded that naïve bayes and Apriori algorithms serve a great purpose in the diagnosis of diseases on the data set referred, in addition as data set grows, diseases uncovered are added with better scope of diagnosis with accurate predictions in future.

3. Proposed System

Many studies have been done on online disease prediction systems. These studies involved various Machine Learning algorithms and a variety of technologies. People have worked on algorithms like Decision Tree, Naïve Bayes, Convolutional Neural Networks for prediction of certain diseases. Developments in technologies like voice recognition

systems have reduced the difficulty of communication between humans and machines. Hence, using similar methods and building an online healthcare service not only increases efficiency of prediction, but also provides a system with high availability and greater usability. The block diagram of the proposed model is as shown in fig 3.1.

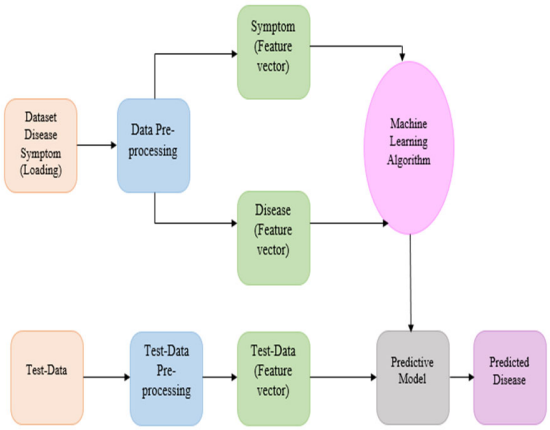

Fig 3.1 Block diagram of the proposed model.

The proposed methodology of this work, "Digital Doctor" is mainly based on the speech-to-text systems and Machine learning concepts. Here, patients can register themselves by providing their personal details, verify and proceed to speak about the symptoms they are facing. The Google Speech API used will take the voice as input, extract the keywords (symptoms) based on the dataset used, followed by the main algorithm that is applied on the symptoms to predict the disease based the same dataset used earlier. A few reliable home remedies and drugs that can be used temporarily is displayed and the patient is redirected to the Medplus® store website where the drugs can be purchased. A consolidated report is generated which can be downloaded by the patient and used while consulting their doctors directly.

3.1 *Applications*

Certain situations for example, the Covid-19 pandemic has caused the governments to impose lockdowns almost all over the world. In such situations, it is important to stay home to be safe and healthy. an online healthcare service comes in handy, to help the users to be safe if they notice any early symptoms of health issues[22].

- **Speech-to-text processing:** The voice of the patient is processed to extract the symptoms.
- **Disease prediction:** The diseases can be predicted during the early stages, to avoid further complications related to treatment.
- **Treatment suggestion:** Some of the most effective immediate measures are suggested based on the disease and the users are directed to the Medplus® website where the suggested medicines can be procured.
- **Consolidated report:** A detailed report is generated that contains information about the disease and suggested treatments which will aid the doctors towards further course of action.

4. Methodology

The below mentioned steps gives the methodology used in the design of the system and the same is as illustrated in fig 4.1.

Step 1: Creation of the dataset with symptoms and dividing it as training and testing datasets for checking the performance of the algorithm in future.

Step 2: Developing a prediction algorithm in python using a suitable algorithm.

Step 3: Devising an algorithm towards suggesting the necessary treatment for specific disease(s).

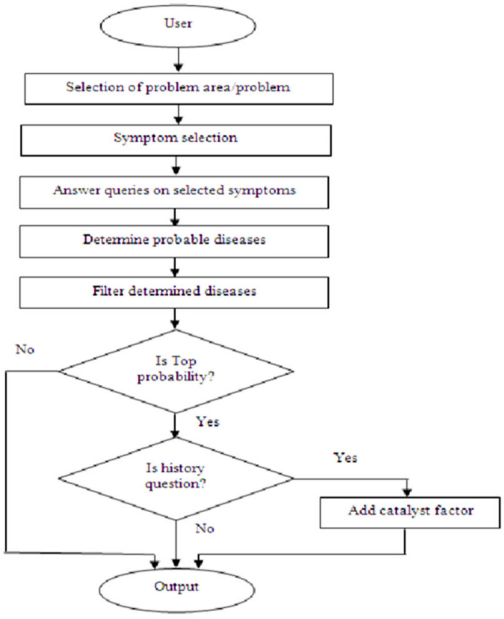

Figure 4.1 The Proposed Methodology

5. Implementation

The Google Speech to Text Conversion API has been used in this work to generate the results based on the patient interaction using voice [1][2].

Input: Patient interacts with the API with the symptoms.

Output: The speech as recorded by the API from the patient is converted to text and is stored in a csv file format.

The implementation details of the google speech to text API is as illustrated below:

```
import speech_recognition as spr
rec= spr. Recognizer()
with spr. Microphone() as source:
print (Welcome!\n How are you ?\n How am I assist you?")
audio=rec. listen(source)
try:
value=rec. recognize_google(audio)
print(" As said {}".format(value))
myfile=open("Patient_symptoms.csv","w")
myfile.write(value)
myfile.close()
except:
print(Sorry, not able to recognize! Can you please repeat once again!")
```

5.1 Dataset

The designed system consists of two datasets, namely the prediction dataset and the treatment dataset.

The prediction dataset was formed by referring and analyzing many other dataset examples available on GitHub. The data as used in the process of prediction of diseases is cleaned first, preprocessed before it is submitted to the proposed algorithm for training and testing.

The dataset can be termed as string dataset as it contains string in form of 'yes' and 'no' where 'yes' refers to the matching of the right symptoms and 'no' refers to the matching up of the wrong symptoms.

The treatment dataset was formed by carefully referring to many credible resources on the internet. The treatment data set consists of the rows where the first cell consists of the disease name followed by the necessary home remedies to be followed by the user and the recommended drug / medications for the disease.

5.2 Pseudocode

The pseudocode is given below:

Step 1: Record the patient's voice using Google Speech Recognition API.

```
Rec : Spr.Recognizer()
        rec.adjust_for_ambient_noise(source)
  audio : rec.listen(source)
```

Step 2: Recorded voice is written to wave audio file.

```
        f.write(audio.get_wav_data())
```

Step 3: Convert the wav audio file into a CSV file.

```
audio_file : ('patient.wav')
      audio: rec.record(source)
try:
  txt : rec.recognize_google(audio)
  myfile: open('Patient_Symptom.csv','w')
  myfile.write(txt)
  myfile.close()
      print 'Sorry, could not understand Audio'
except Spr.RequestError as e:
  print 'Could not request results from Speech Recognition Service'
```

Step 4: Extract the symptoms using the CSV file.

```
fr: src.read()
sym:list()
sentences:fr.split(".")
   for sentence in sentences:
print '{} key words in sentence:'.format(sum(1 for word in search_keywords if word in sentence))
    get_close_matches(word, patterns, n=2, cutoff=0.7))
    sym.append(word)
print sym
```

Step 5: Predict the disease based on the symptoms on questions as asked to the patient.

```
x : most_frequent(listOfData)
listOfAsk : list(empDfObj.loc[x])
ques: list(set(listOfAsk) - set(psymptoms))
pattern :  rec.compile(r"^no$")
result : [pattern.sub("", item) for item in questiond]
ques:set(questions)
result :set(result)
ask  :list(ques & result)
ans : list()
      for i in ask:
  print 'Do you have '+i+'?'
 ans.append(input('Enter Yes or No'))
  print 'You may have '+disease(x)
```

Step 6: Suggest Suitable treatment based on the disease predicted (home remedies and drugs).

print 'TREATMENT'

print treatment(disease(x))

Step 7: Display the disease and corresponding treatment on the screen.

5.1 : Pseudocode _ Digital Doctor

5.3 Challenges faced

1. Finding the correct, credible data while forming the datasets.
2. Forming the correct algorithm for the prediction module which also includes the interactive method with the user.
3. Finding the feasible sources for finding the correct data regarding the treatment both home remedies and drugs as available at pharmacies.

6. Experimental Results

The algorithm has been tested for around 80 different cases(diseases) with various symptoms and occurrence patterns for many different patients. The screenshots of the system are as shown below:

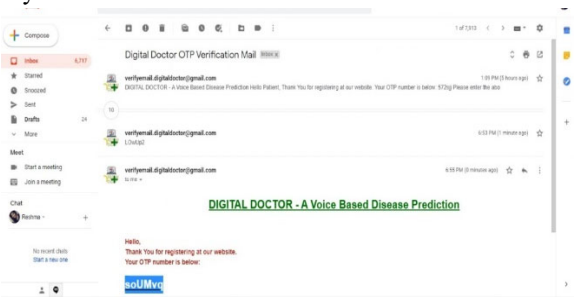

Fig 6.1 Verification E-mail

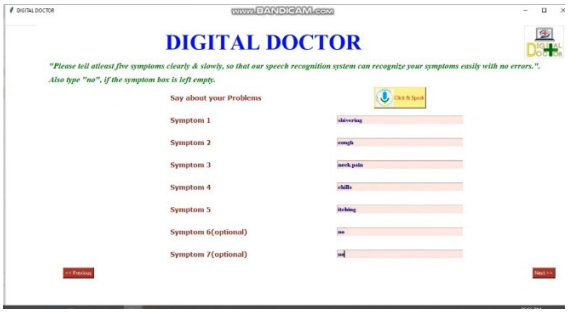

Fig 6.2: Extraction of symptoms

Fig 6.3: Questionnaire and disease prediction

Fig 6.4: Treatment suggestion

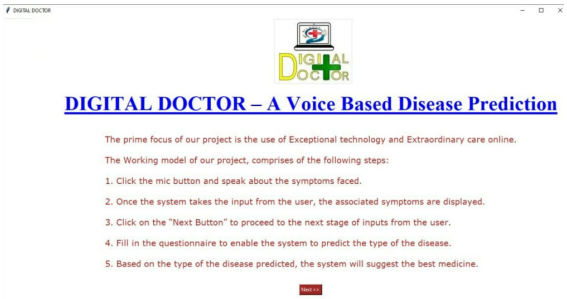

Fig 6.5 GUI frame page 1.

Fig 6.5 illustrates the first page of the application, that provides the basic information and the rules for using the application which the user / patient should follow.

Fig 6.6 GUI frame page 2.

As shown in fig 6.6, the web page provides the simple form for the user to fill the details for further correspondences if required.

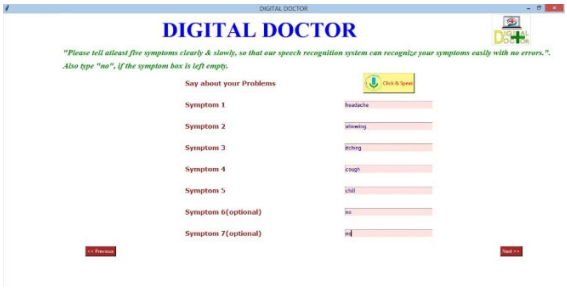

Fig 6.7 GUI frame page 3.

In fig 6.7, the Google speech to text API converts the voice to text and fetches valid symptoms in respective symptom textbox.

Fig 6.8 GUI frame page 4.

The algorithm asks interactive questionnaires to predict the disease more accurately and recommends the required medication as shown in fig 6.8.

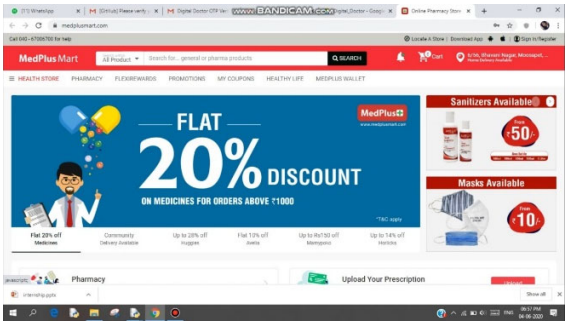

Fig 6.9 The Medplus Mart Website

The user is directed to the Medplus website when the "Want to buy medicines" button is clicked as shown in fig 6.9. Here, the suggested drugs can be purchased.

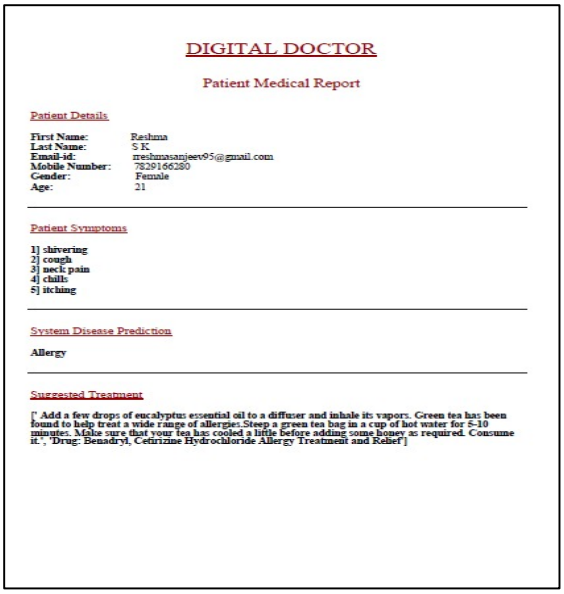

Fig 6.10 Consolidated Medical Report

The user can download a report consisting of personal details and the disease predicted with the suggested treatments as shown in fig 6.10.

7. Conclusion

The proposed methodology has produced good results for predicting the disease according to the patient's input. The approach also recommends the necessary treatment or medications for the user. However, it may not predict properly if the voice samples have too much disturbance. An experimental result shows that proposed method is very effective and efficient in detecting and converting the voice samples to text and extracting the accurate symptoms only. Dataset contains a wide variety of all the diseases and its symptoms and performance is excellent overall. Although, the performance is evaluated on a small test set, but the results are encouraging and hope that performance evaluation of these on a large test set will validate these results and conclusions.

8. Future Scope and Enhancements

The model as designed can be extended to introduce more robust version to support the users offering natural language interface and connecting the users to specialists in the domain of interest.

Acknowledgments

The authors would like to thank Deanship of Scientific Research at Majmaah University for supporting this work under **Project Number No. R-2022-13.**

References

[1] G. Salton, C. S. Yang, C. T. Yu, ―A Theory of Term Importance in Automatic Text Analysis‖, Journal of the American society for Information Science, 26(1), 1975, (pp. 33-44).

[2] J. D. Cohen, ―Highlights: Language and Domain independent Automatic Indexing Terms for Abstracting Journal of the American Society for Information Science, 46(3): 1995, (pp. 162-174).

[3] Frank E., Paynter G.W., Witten I.H., Gutwin C., Nevill-Manning C.G., ‖ Domain-specific keyphrase extraction‖, Proceedings of the Sixteenth International Joint Conference on Artificial Intelligence, San Francisco, CA, USA, 1999, (pp. 668-673).

[4] M. Ortuño et al., ―Keyword detection in natural languages and DNA‖, Europhys. Lett. 57, 2002 (p. 759).

[5] Jingdong Chen, Member, Yiteng (Arden) Huang, Qi Li, Kuldip K. Paliwal, "Recognition of Noisy Speech using Dynamic Spectral Subband Centroids" IEEE SSIGNAL PROCESSING LETTERS, Vol. 11, Number 2, February 2004.

[6] Hakan Erdogan, Ruhi Sarikaya, Yuqing Gao, "Using semantic analysis to improve speech recognition performance" Computer Speech and Language, ELSEVIER, (2005).

[7] New York Presbyterian Hospital 2004. Disease-Symptom Knowledge Database AMIA Annu Symp Proc.2008. PM-CID: PMC2656103 (pp. 783-7).

[8] AN. Sigappi and S. Palanivel, "Spoken Word Recognition Strategy for Tamil Language", International Journal of Computer Science Issues(IJCSI), Vol. 9, Issue 1, No 3, ISSN (Online):1694-0814 , January 2012, (pp. 227-233).

[9] Predictions in Heart Disease Using Techniques of Data Mining, "2015 1st International Conference on Futuristic trend in Computational Analysis and Knowledge Management ((ABLAZE-2015)").

[10] Sifatullah Siddiqi School of Computer and Systems Sciences Aditi Sharan, School of Computer and Systems Sciences "Keyword and Keyphrase Extraction Techniques: A Literature Review", International Journal of Computer Applications (0975 – 8887) Volume 109 – No. 2, January (2015).

[11] Prerana Das, Kakali Acharjee, Pranab Das and Vijay Prasad, Department of Computer Science & Engineering and Information Technology, School of Technology, Assam Don Bosco University, Assam, India, "VOICE RECOGNITION SYSTEM: SPEECH-TO-TEXT", Journal of Applied and Fundamental Sciences · November (2015).

[12] Ajinkya Kunjir, Harshal Sawant, Nuzhat F.Shaikh, "Data Mining and Visualization for prediction of Multiple Diseases in Healthcare, " in IEEE big data analytics and computational intelligence, Oct 2017 (pp. 23-25).

[13] Implementing WEKA for medical data classification and early disease prediction. "3rd IEEE International Conference on "Computational Intelligence and Communication Technology" ((IEEE-CICT 2017)).

[14] M. Chen, Y. Hao, K. Hwang, L. Wang, and L. Wang, ''Disease prediction by machine learning over big data from healthcare communities,'' IEEE Access, vol. 5, no. 1, 2017, (pp. 8869–8879).

[15] Manjutha M, Gracy J, Dr P Subashini, Dr M Krishnaveni, "Automated Speech Recognition System – A Literature Review", International Journal of Engineering Trends and Applications (IJETA) – Volume 4 Issue 2, Mar-Apr (2017).

[16] Harini D K, Natesh M, "PREDICTION OF PROBABILITY OF DISEASE BASED ON SYMPTOMS USING MACHINE LEARNING ALGORITHM", International Research Journal of Engineering and Technology (IRJET) ,Volume: 05 Issue: 05 | May- (2018).

[17] Shratik J. Mishra , Albar M. Vasi , Vinay S. Menon, Prof. K. Jayamalini, Department of Computer Engineering, Shree L.R. Tiwari college of Engineering, Maharashtra, India, "GDPS - General Disease Prediction System", International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 03 | Mar- (2018).

[18] Sayali Ambekar and Dr.Rashmi Phalnikar, Department of Information Technology, MIT-COE, Pune "DISEASE PREDICTION BY USING MACHINE LEARNING", International Journal of Computer Engineering and Applications, Volume XII, Special Issue, www.ijcea.com ISSN 2321-3469 (May 18,).

[19] Allen Daniel Sunny, Sajal Kulshreshtha, Satyam Singh, Srinabh, Mr. Mohan Ba, Dr. Sarojadevi H, ("Disease Diagnosis System by Exploring Machine Learning Algorithms",) International Journal of Innovations in Engineering and Technology (IJIET),2018.

[20] Automated Water Tap Controlling System Using Machine Vision, Dr. Khalid Nazim Abdul Sattar, IJCSNS, International Journal of Computer Science and Network Security, Vol. 19 No. 12, pp. 91-95, December 2019.

[21] Detection of Levels of Blood Sugar Using Simple IoT Based Breath Analysis, Dr. Khalid Nazim Abdul Sattar et. al, IJCSNS, International Journal of Computer Science and Network Security, Vol. 20 No. 8 pp. 21-29, August 2020.

[22] Developing a Prediction Model Using J48 Algorithm to Predict Symptoms of COVID-19 Causing Death, Dr. Khalid Nazim Abdul Sattar et. al, IJCSNS, International Journal of Computer Science and Network Security, Vol. 20 No. 8 pp. 80-83, August 2020.

[23]"Speech Recognition using Google Speech API|", [Online].Available :https://pythonspot.com/speech-recognition-using-google-speech-api/.

[24] " Creating PDFs with fpdf2 and Python", [Online].Available https://www.blog.pythonlibrary.org/2018/06/05/creating-pdfs-with-pyfpdf-and-python/.

Authors Profile

Dr. Khalid Nazim Abdul Sattar, Assistant Professor, Department of CSI, College of Science, Majmaah University, Az Zulfi, Kingdom of Saudi Arabia, received his B. E. Degree from Bangalore University, M. Tech from VTU Belagavi, and Ph.D. in Computer Science & Engineering from Singhania University, Rajasthan, India. He has 07 years of research and 14 years of teaching experience and his research expertise include but are not limited to Image processing, digital signal processing, Artificial Intelligence, Internet of Things, Cryptography, Data & Network Security and Data mining.

Dr. Mutasim Mohamed Al Sadig, Assistant Professor, Department of CSI, College of Science, Majmaah University, Az Zulfi, Kingdom of Saudi Arabia, received his Bs in Science and Technology & M. Ec(CS) from GAZERA University, Sudan. PhD in Information Technology, from Academic Sudan University. He has 20 + years of research and teaching experience and his research expertise encompasses Data Mining, Biometric Identification System , Software Engineering, Artificial Intelligence, and Computer Networks.

Mr. Ahsan Ahmed, Lecturer, Department of Information Technology, College of Computer and Information Sciences, Majmaah University, Al-Majmaah, Saudi Arabia, received his M. S. in Computer Science from Jamia Hamdard University, New Delhi, India in 2008, & B. S. in Mathematics from Mahatma Jyotiba Phule Rohilkhand Bareilly University, India in 2006.

He has 13 + years of research and teaching experience and his research expertise encompasses Web Technologies, E Learning & Internet of Things.