

MediAssistEdge – Simplifying diagnosis procedure & Improving patient doctor connectivity

Amiya Kumar Tripathy^{1*}, Rebeck Carvalho², Ajit Puthenputhuserry³, Nikita Chhabhaiya⁴, Bijoy Anthony⁵
^{1,2,3,4,5} Department of Computer Engineering, Don Bosco Institute of Technology, Kurla (W), Mumbai, India

^{1*}School of Computing and Security Sciences, Edith Cowan University, Perth, Australia

¹tripathy.a@gmail.com, ²maaask3@gmail.com, ³varghese.ajit@yahoo.in, ⁴nixie25292@gmail.com, ⁵bjantony2@gmail.com

Abstract— Medical Decision is very specialized and challenging job. This is due to the fact that certain decisions may be wrong due to misdiagnosis. This wrong diagnosis decision may risk life of a person. It becomes necessary to have a second opinion in such cases. Also availability of efficient doctors to conduct correct diagnosis in a country having large population is certainly less. Considering these facts, MediAssistEdge system aims at conducting diagnosis remotely as well as providing basic diagnosis of diseases which does not require prescription. MediAssistEdge system consists of two subsystems to carry out the two mentioned goals. The first goal is attained by MediConnect system which provides an interface wherein patient and doctor or doctors around the world can be connected remotely. The ideology of remote diagnosis in true sense is made possible with the help of the two assisting hardware devices which comes integrated with the system. The second goal of diagnosis of disease is implemented by the DocBot subsystem which is an Artificial Intelligence (AI) engine to interact with patients. It has an interface wherein a representation of a doctor will be present with a reply box. The user interacts with the artificial intelligence engine like normal chatting. Based on the inputs from the user the AI engine will provide diagnosis. The doctors will also be able to teach the AI engine. The patients that require second level diagnosis will be referred to the hospital.

Keywords- *remote diagnosis, video conferencing, artificial intelligence, mediconnect, docbot, e-stetho, diagnocam*

I. INTRODUCTION

Even though there have been tremendous advances in communication technology, these advances have not been reflected in medical field. From conducting tests for the diagnosis of diseases to the treatment of diseases, new techniques have been found and used. Unfortunately, there is no significant way established for better communication and remote diagnosis. There are cases wherein people die due to unavailability of basic healthcare services. In developing countries with large population, availability of efficient doctors is limited and quiet inaccessible [1]. Good doctors prefer to work in cities rather than small town or villages. A medical center in small village might not have facilities as what a clinic in a city would have. The biggest challenge for delivering health care in rural areas is access, particularly the physical distance between services and patients. This not only causes problems with time, but also costs the patient money. More unproductive time and money are spent travelling to see patients, attending meetings and accessing continuing

professional development for staff. These factors might lead to majority of people not getting the quality basic healthcare services [5].

MediAssistEdge system is designed to provide a solution for the above mentioned problems. It aims at conducting diagnosis remotely as well as providing basic diagnosis of diseases which does not require prescription. The system consists of two subsystems- MediConnect system and DocBot system.

Seeking medical help in a country having large population is not so easy. Especially during epidemics, when disease affects a large number of people, doctors in that area are overburdened and cannot give their services to all at a time. Consider another scenario in which two doctors, one from India and other from United States, want to discuss on a topic, they will have to share the related documents by mailing to each other and then use audio and video chat to discuss. Systems like Skype or Teamviewer can be used as they allow audio, video as well as textual chat but there is no provision to highlight or edit on the document in real time. An attempt is made to solve these problems using MediConnect system. MediConnect system provides a platform to doctors and patients to interact remotely. It is a video conferencing system which provides the audio, video and textual chat facilities which can be done simultaneously as well as an additional facility of white-board module. The white-board module is an interface that solves the situation requiring sharing of documents and highlighting on them in real time. When it comes to diagnosing patients, doctors need various hardware devices, one among them is stethoscope. In order to provide this purpose, there are two hardware devices developed to assist the MediConnect system. These devices are e-Stetho (electronic Stethoscope) and DiagnoCam (Diagnosis Camera). e-Stetho is a modified stethoscope to provide digital output so that it can be transmitted. Doctors can use this device just like how they use normal stethoscope. Only the difference will be that one end which is the stethoscope head will be with the patient and the output will be transmitted via the system to the doctor on the other end. The DiagnoCam is a portable web camera with light up facility so that it might be able to detect tonsillitis, skin diseases, etc. The patient will be able to hold the DiagnoCam at the proper place focusing on particular area so that the doctor on the other end can see that area. At present, there is no system which provides these services. Thus, MediConnect system assures to provide a better

platform for doctors to communicate with their patients or with other doctors.

The second goal of MediAssistEdge system is achieved by the DocBot system which provides diagnosis to patients using an AI engine. This diagnosis will be done of diseases not requiring medical prescription [2]. The DocBot system is made to diagnose and treat the first aid type of diseases. It will interact with patients like normal talking with a doctor. Based on user response, the system will provide the method to treat the disease [3]. If the disease is serious then the system will refer the user to a hospital. The main purpose of the DocBot system is to provide easy access, anytime availability and anonymity to the users. The system will be available all the time so as to facilitate free basic healthcare to everybody.

II. MEDICONNECT SYSTEM - OVERVIEW

A. Architecture Overview

MediConnect is the video conferencing system that helps patients to get connected to a Doctor and thus the doctor can examine the patient. Thus MediConnect would help to overcome the distance barrier.

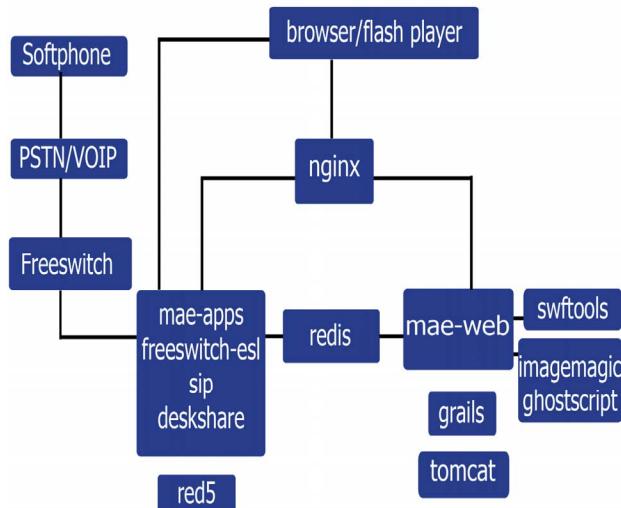


Figure 1 Architecture Overview

As shown in figure 1 the Nginx engine proxies the mae-web and the mae-apps to support RTMPT(Tunelling with RTMPT encapsulated in HTTP). It uses Nginx server to route packets to the tomcat6 application running on port 8080.

RTMPT is used to tunnel RTMP data with HTTP. RTMP (Real Time Messaging Protocol) is used for video streaming applications and communication. The Grails application handles creating and scheduling the conference. The system contains a whiteboard module to which pdf documents can be uploaded. This whiteboard module is visible to all the participants logged in a conference room. In order to display and enable live highlighting of the documents, the pdf slides have to be converted to flash. Swftools provide collection of tools to convert pdf documents to flash slides. If the Swftools is not able to convert the pdf documents to flash slides, it uses imagemagic and ghostscript to perform the same steps. Red5

server is an open source media server and is used to synchronize all the clients taking part in conference. Ghostscript is interpreter for post script language and for PDF documents. Imagemagic can read and write images and supports up to 100 image formats. It is used to highlight and make markings in the images uploaded. This module particularly helps the doctors to highlight and mark important reading or points while communicating with each other remotely.

Freeswitch-esl issues commands to Freeswitch (Voice Conferencing Server) and allows users to issue commands such as mute/unmute/remove user. Deskshare module is an application in order to enable sharing of pdf documents to the users.

SIP (Session Initiation Protocol) is a signal communication protocol to control multimedia sessions such as voice calls and video calls over the IP (Internet Protocol). It also allows connection of PSTN (Public Switched Telephone Network) to the Freeswitch server, therefore allowing telephones to be connected to the conference system [7].
temp.pdf

B. Application Overview

Application overview shows all the modules included in the MediConnect system. It also shows the interaction between various components of the system and the communication between them.

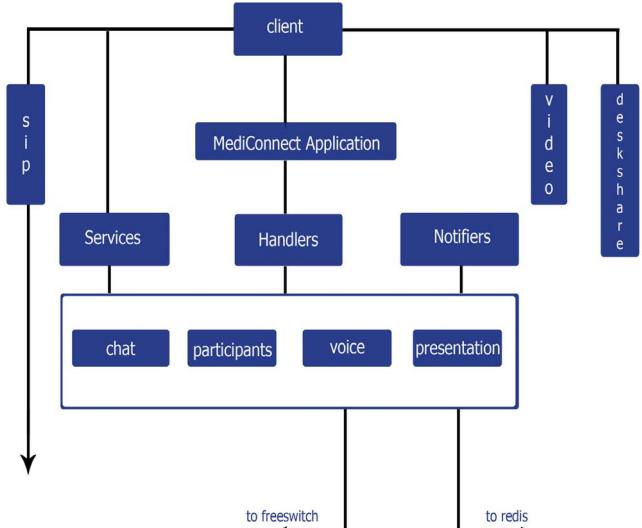


Figure 2 Application Overview

The applications available are chat, participants, voice and video as shown in figure 2. The chat module allows the participants to share the same chat window. It contains a common chat window which is visible to all the participants. Any new entries made in the chat window are notified to all the participants. Participant's module helps multiple users to enter into the chat room. It shows the users who are currently logged into the system and also displays the status of each user in the system. The voice module helps for successful transmission of

audio between the participants. Participants can also perform actions such as mute/unmute other users. The presentation module helps to share presentation between the participants. Participants can also perform live highlighting in the files uploaded, thereby simplifying the communication process.

Handlers handle the client joining and leaving the conference room. It also sets up the application and loads the basic modules. Services handle the remote method calls from the client. It services all the requests from the clients. Notifiers synchronize the clients using shared object. It helps to avoid timing issues between different clients. Voice module uses the FreeSwitch server to send audio signals. The presentation module sends the flash slides to the redis server.

The video module is used for video communication and uses Red5 server. The deskshare module is used in order to share desktop between the clients. This module is used in order to share report between doctors. The entire system will be implemented online; thereby will be available to all people accessing the Internet. Specific conference rooms will be created based on the diseases. For ex: there could be four conference rooms namely, General, Cardiac, Orthopedic and Eye. The patient on entering the exact credentials will be able to log into the specific conference room [7, 8].

C. Presentation overview

Presentation overview shows the white board module with all its components and the interaction between them. The white board module helps the user to upload documents [8].

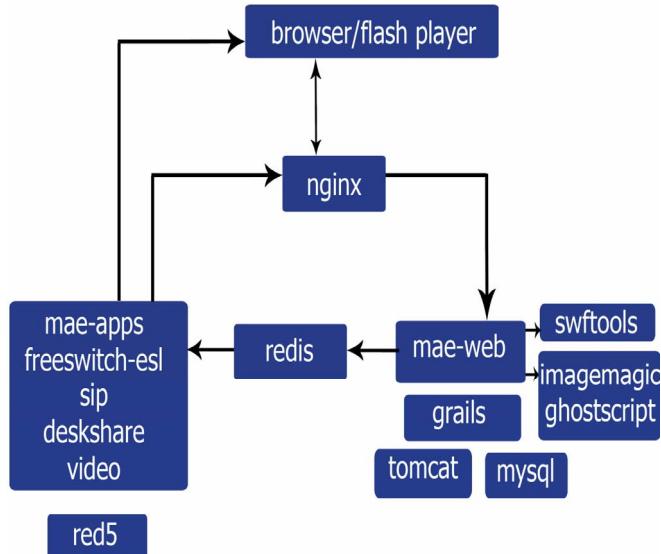


Figure 3 Presentation Overview

As shown in figure 3, the user uploads the presentation to the nginx module. Nginx module is the module used for sharing flash slides. The pdf uploaded by the client goes to the bbb-web. The bbb-web is the server which handles pdf files. It uses swftools to convert the pdf into flash slides so as to facilitate desktop sharing of the pdf file. If this fails, then it

uses imagemagick or ghostscript in order to convert the pdf file to images.

The flash images are then transferred to the redis server which publishes the flash images. It sends the flash to the bbb-apps which uses red5 server to transmit the flash to the nginx module. The nginx module also provides tools in order to control the flash presentation [7].

III. HARDARE DEVICES

The hardware devices that are used in the system are e-Stetho (electronic stethoscope) and DiagnоСam (Diagnosis Camera). The Hardware devices are used along with the Video conferencing module to help the doctor to examine the patients with higher efficiency. The hardware devices used will be available with the patients and doctors will instruct the patients on where to place the hardware devices.

A. e-Stetho (Electronic Stethoscope)

Acoustic stethoscopes is commonly known to most of the people, as it operates on the transmission of sound that is captured using a chest piece, via air-filled tubes that are hollow, so that the listener can hear the sound. The chest piece normally constitutes a hollow cup called "bell" and a diaphragm (plastic disc) which is placed on the patient's heart for capturing the sound (heart beats). The bell or hollow cup is in light contact with the skin to hear sounds of low frequency and the diaphragm has firm contact with the skin to hear sounds of high frequency. Acoustic stethoscope has one disadvantage that the sound level is too low thus making it practically not suitable to use it in a noisy environment. Though it has a disadvantage, acoustic stethoscope is used more commonly nowadays [4].

Electronic stethoscope serves similar function as that of acoustic stethoscope. The difference between the two is that electronic stethoscope captures the sound, and then converts the signal which can later be processed for listening [14].

Most of the systems which are portable have one battery. Therefore, there was an increase in the popularity of portable equipment. The implementation of op-amp circuits was advantageous because of their balanced dual supplies, but there was more of energy consumption. So the need for single-supply operations was more desirable where energy would be conserved. But the single-supply operation also has its own drawbacks. It requires an additional passive component after every stage. And also, many instability problems occur due to improper execution of the design [12].

The circuit shows a single-supply biasing method. 9V has been chosen as the voltage supply, because of its compatibility with the earphone, op-amp and power amplifier used in the circuit. The op-amp used is a non-inverting op amp circuit, which uses a resistor divider with two biasing resistors, R5 and R6. This is done to set the voltage on the non-inverting input of the op-amp equal to $V_{cc}/2$. R5 and R6, both are taken of equal values, by considering the power consumptions and allowable noise.

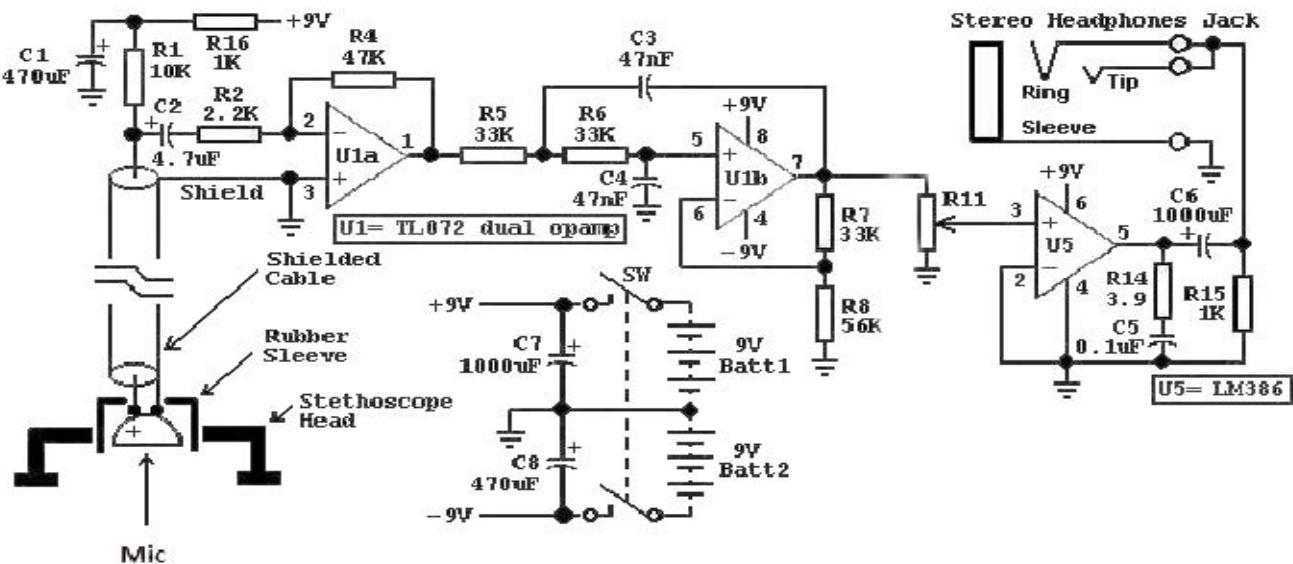


Figure 4 Circuit Diagram of e-Stetho [Modified from: <http://www.aaroncake.net/circuits/steth.asp>]

As shown in figure 4, the resistor value (R4) is chosen as $47\text{k}\Omega$ so as to extend the conservation of supply current. Small resistor values will increase the power-supply current consumptions. This may overheat the resistors, which is certainly not a good design approach.

Larger values of capacitor are needed, so that effective bypassing through the voltage divider for all set of frequencies can be done. The frequencies should be within the circuit's passband. This also avoids the substantial feedback at low frequencies through the power supplies. The capacitor value selected was 47nF (C3). With a $33\text{k}\Omega/33\text{k}\Omega$ voltage divider for R5 and R6, it provides -3dB bandwidth of this network's impedance. The common-mode rejection ratio will drop below 7Hz . There will be instability, as the electret condenser microphone will only pick up signals above 20Hz .

The microphone should able to pick up sounds which is in the range of 20Hz to 2kHz . The sensitivity of the microphone must also be taken care of. It should be able to reproduce the correct intensity of body sounds that it had received [13].

Dynamic Microphone do not have flat frequency response. Dynamic microphone operates with the principle of electromagnetism as it does not require voltage supply. It is suitable for handling high volume level, such as musical instruments. The signal produced is strong therefore making them sensitive. Condenser Microphone has a flat frequency response. It is not ideal for high volume work as its sensitivity makes it prone to distortion. The resulting audio signal is stronger than that from a dynamic microphone. It also tends to be more sensitive and responsive than dynamic microphone audio signals [14].

A condenser microphone is more desirable as compared to dynamic microphone .The condenser microphone is used when accurate sound considerations are required in the circuit.

Heartbeat and respiration sounds are passed, and external noise and background sounds are reduced. Frequency switching takes place from heart beats ($20\text{~}100\text{Hz}$) to

respiration sounds ($20\text{~}1000\text{Hz}$) which allows the listener to hear one particular sound.

For heart sounds ($20\text{~}100\text{Hz}$),

Since $R5 = R6 = 33\text{k}\Omega$ and $C3 = C4 = 47\text{nF}$

For respiration sounds ($20\text{~}1000\text{Hz}$),

Since $R5 = R6 = 33\text{k}\Omega$ and $C3 = C4 = 4.7\text{ nF}$ [14]

The op-amp in the second-order Sallen-Key filter acts as a non-inverting amplifier with the negative feedback provided by the $R7/R8$ network. The damping factor is set by the values of $R7$ and $R8$, thus making the filter response Butterworth. The $R7/R8$ ratio must be 0.586 to produce the damping factor of 1.414 which is essential for a second-order Butterworth response. For a Butterworth response,

$$R7 / R8 = 0.586$$

By choosing $R8 = 56\text{k}\Omega$, overall gain obtained by the ratio of resistors $R7$ and $R8$ is 1.60 .



Figure 5 e-Stetho Image

The LM386 circuit is an audio amplifier which is designed only for use in low voltage consumer applications. It provides both voltage and current gain for signals in the circuit. The inputs are given ground reference and output is biased to one-half of the supply voltage that is provided. The quiescent power drain is only 24mW using a 6V supply.

It is used for low-power audio applications. Also LM386's gain-frequency curve can be shaped with some external feedback. The gain is usually set internally to 20 to keep external part count low, but gain can increase from 20 to 200. C6 capacitor couples the audio signal but blocks half the supply of DC voltage at the output of the LM386, which stops the signal reaching the earphones.

B. DiagnoCam

This device will be used to view any specific body region like skin, throat, etc. The doctor can see the body tissue in case of any rashes or allergies. Additional light-up facility will be added to this device so that the doctor can view the specific body part clearly and can identify. This device can provide detailed image of the any body part so that the doctor can view and analyze whether there is any abnormality to that body part.

This device is also useful to detect tonsillitis and other throat diseases, therefore will help the doctor to improve the efficiency of diagnosis. The camera visuals will be available to the doctor at the other end and the patient will be able to switch displays between the DiagnoCam and the integrated web camera. Users will also be able to publish the visuals to multiple doctors. This device will also be integrated to the video-chat.



Figure 6 DiagnoCam Image

IV. DOCBOT (DOCTOR BOT)

The DocBot is a php interpreter based on PHP (Hypertext Preprocessor), MySQL and AIML (Artificial Intelligence Markup Language). Chatbots are pieces of computer software that try to engage in an intelligent conversation with the user. Chatbots try to understand the present state of the user and respond accordingly. Normally, chatbots are used to make interactive websites, virtual assistants, virtual agents, etc. In the

system, chatbot called as DocBot (Doctor Bot) is developed which is used for medical purposes. The user interacts with the DocBot by answering the questions asked by it. Based on the responses, the DocBot tries to understand the problem faced by the user and tries to reach a particular pattern. It then further queries the user to understand more about that particular pattern and based on all responses, provides solution to the problem faced by the user [2].

The docbot stores patterns of all diseases in AIML files. Each pattern has a response which is stored as a template. On finding a particular keyword in the search box entered, the php interpreter finds the pattern in the aiml files and based on the pattern gives the appropriate response. The user history is saved in the database to which data mining techniques are applied in order to give higher priority to frequent patterns.

Pseudocode of AIML file

```
<category>
    <pattern>Pattern Name</pattern>
    <template>
        <think><set name="step" > 1a </set></think>
        <random>
            <li>Response to be given for that pattern</ li>
        </random>
    </template>
</category>
```

AIML language offers a rich set of tags which makes it possible to perform different functions such as trying to understand the state of the user, better access to database and develop responses based on current state. Wild cards such as * and _ can be used which help us to improve the range of a pattern. * indicates minimum of 1 characters required and _ indicates zero or more characters required [9-11].



Figure 7 Screenshot of DocBot

First aid database has been taken as a test set for the docbot. The test set covered up to 400 first aid disease patterns with the specific sub-branches. In the example as shown in Fig. 7, the user enters "I have allergy". Based on the input the DocBot will further query the user by entering "Do you have epinephrine auto injector?" The user can provide a positive or a negative reply. Suppose the user enters "No, I do not know to use it", the DocBot then will provide the method on how to use the auto injector. The DocBot asks further questions to the user

and tries to understand the problem faced by the user more accurately. Entire user data is saved in the database and based on the occurrence of each pattern, weights are assigned. Therefore a pattern which is accessed frequently will have a higher weight as compared to a pattern which is accessed less frequently. Patterns with higher weights are more easily accessible to the users.

The DocBot admin panel provides features such as Spell Check, Word Censor, Teach, Stats tool, etc. Spell Check checks for misspelled words and automatically replaces it with the correct word. Therefore, even though the input is not entered correctly by the user, the interaction continues. Word Censor censors filthy words and provides the appropriate reply to the user. Teach tool provides interface to administrators to add aiml files to the system. It also helps to edit and correct the responses of the DocBot. The responses of the DocBot can be improved using this tool. The Stats tool provides database statistics which show the requests made to the database and the load at the database.

V. FUTURE SCOPE

MediConnect system was found to be a useful tool by doctors for checking their patients remotely. It can be improved by adding more medical devices such as Sphygmomanometer or an E.C.G. machine. New modules can be constructed and added so as to provide direct interface in the MediConnect system for more efficient remote diagnosis. The system can also be improved so that it can be made capable for continuous monitoring of patients in hospitals.

While the system is providing direct access to connect to a doctor, care has to be taken that this should not be misused. For this purpose, suitable security mechanisms can be incorporated so that the system will be secure and cannot be forged with.

DocBot is currently made for assistance in treating first aid diseases. The input given to the system is in textual form. It can be improved by providing speech input. Also the output can be made in voice form. DocBot being an Artificial Intelligence Engine can be improved to provide counseling to the patients.

VI. CONCLUSION

In MediConnect system, by using various modules and the cost efficient hardware devices, an attempt has been made to assist the doctors to carry out remote diagnosis of patients. The system was tested by doctors and the system was found to be very useful for them. The DocBot system provides a user friendly way to carry out diagnosis and treatment of first aid diseases.

If the MediConnect system would be incorporated by the government in developing countries and health care centers would be constructed, it would provide health care services at the least cost to all people. It would simplify the job of doctors to treat his/her patients from any location. Also the patients who cannot afford to visit doctors can get health care services easily.

MediConnect is a system to not only connect doctors and patients but also to connect doctors and medical experts from all over the world. The system provides facility to carry out board room conferencing remotely. The doctors and medical experts can use it to discuss on serious or new medical cases.

The DocBot system provides an interactive and user friendly way to treat first aid diseases. It is tested by many users belonging to different age groups and the response given by them stated that it is an easy and efficient tool for seeking help in treatment of first aid diseases.

Currently the MediAssistEdge system is termed as useful by doctors and other users. The mentioned improvements if incorporated can make the MediAssistEdge system more efficient and user friendly to be used by anybody at anytime.

REFERENCES

- [1] Isola, R.; Carvalho, R.; Tripathy, A.K., "Knowledge Discovery in Medical Systems Using Differential Diagnosis, LAMSTAR, and -NN," Information Technology in Biomedicine, IEEE Transactions on , vol.16, no.6, pp.1287,1295, Nov.2012J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [2] Zhi-Hua Zhou; Yuan Jiang, "Medical diagnosis with C4.5 rule preceded by artificial neural network ensemble," Information Technology in Biomedicine, IEEE Transactions on , vol.7, no.1, pp.37,42, March 2003.
- [3] Smita Sushil Sikchi and Sushil Sikchi and M. S. Ali, "Artificial Intelligence in Medical Diagnosis," International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11, 2012.
- [4] Ukeessays.co.uk. 2014. Electronic stethoscope converts acoustic sound waves. [online] Available at:<http://www.ukessays.co.uk/essays/engineering/electronic-stethoscope-convert-acoustic-sound-waves.php#ixzz2wuGBe7Vl> [Accessed: 26 Dec 2014].
- [5] R. A. Miller, "Medical diagnostic decision support systems—Past,present, and future—A threaded bibliography and brief commentary,"J.Amer. Med.Inf.Assoc.,vol. 1,pp. 8-27,1994.
- [6] R. Carvalho, R. Isola, and A. Tripathy, "MediQuery—An automated decision support system," in Proc. 24th Int. Symp. Comput.-Based Med. Syst.,Jun. 27–30, 2011,pp.1–6.
- [7] Code.google.com. 2014. ArchitectureOverview - bigbluebutton - Overview of BigBlueButton's Architecture - Open Source Web Conferencing - Google Project Hosting. [online] Available at: <http://code.google.com/p/bigbluebutton/wiki/ArchitectureOverview> [Accessed: 7 Apr 2014].
- [8] Code.google.com. 2014. bigbluebutton - Open Source Web Conferencing - Google Project Hosting. [online] Available at: <https://code.google.com/p/bigbluebutton/> [Accessed: 7 Apr 2014].
- [9] Foundation, A. 2014. A. L. I. C. E. The Artificial Linguistic Internet Computer Entity. [online] Available at: <http://alice.pandorabots.com/> [Accessed: 7 Apr 2014].
- [10] Cleverbot.com - a clever bot. [online] Available at: <http://www.cleverbot.com/> [Accessed: 7 Apr 2014].
- [11] Elbot the robot [online] Available at: <http://www.elbot.com/> [Accessed: 7 Apr 2014].
- [12] Stethoscope, E. (2014). Electronic Stethoscope. [online] Instructables.com. Available at: <http://www.instructables.com/id/Electronic-Stethoscope/> [Accessed 28 Oct. 2013].
- [13] Aaroncake.net, (2014). Electronic Stethoscope. [online] Available at: <http://www.aaroncake.net/circuits/steth.asp> [Accessed 12 Dec. 2013].
- [14] Best-microcontroller-projects.com, (2014). Electronic Stethoscope. [online] Available at: <http://www.best-microcontroller-projects.com/electronic-stethoscope.html> [Accessed 28 Nov. 2013].