ABSTRACT

Due to the increasing prevalence and increasing demographics of hearing impairments and deafness in a general population, there is a growing need to introduce stethoscopes for deaf physicians. Therefore identifying technological solutions for enhancing audition (hearing) of deaf physicians should be focused on. Since auscultation (stethoscope hearing) of heart sounds, lung sounds and abdominal sounds are a critical responsibility of every physician, devising tech-savvy solutions for deaf or hard at hearing doctor is critically important in order to allow these professionals to work. Based on the demographics of hard at hearing and deafness in the general population, the need for a “deaf-friendly” stethoscope is evident.

Deaf physicians can overcome their challenge by using a specialized stethoscope adapted with an amplification device. Stethoscopes equipped with features like visual or tactile substitution or amplification can be used in order for these compensatory features to be feasible, they should employ an interface, which is simple and quick to attach. It should be portable (pocket size) and accurately reproduce body sounds.

Keywords

Stethoscope, deaf, hard at hearing, physician

1. INTRODUCTION

Since hearing impairment is the most frequent sensory deficit in human populations, affecting more than 250 million people in the world. Consequences of hearing impairment include inability to interpret speech sounds, often producing a reduced ability to communicate, delay in language acquisition, economic and educational disadvantage, social isolation and stigmatization. It may be worsened by some medical conditions such as hypothyroidism, diabetes, and possibly hyperlipidemia, among others [1].

Using the amplified stethoscope would not work only due to amount of sound the deaf physician can receive, so its better to introduce other technologies so the physician can diagnose the problem accurately. Therefore to overcome this problem new technologies were looked at that will assist the deaf physician. These new technologies are nowadays implied in healthcare due to the plentiful use of prostheses, which are intended to replace, to: modify or to improve essential functions of different defective organs of the human body. We should carefully notice here that new technologies involved concern various domains, especially electronics and or mechanics, and with no doubt the computer-engineering domain. In fact, with regarding to the great development of these technological domains, conjointly with the development of medical science, we could realize that various forms of medical apparatus are now essential for health therapy [2].

Various types of technologies were looked at in detail, which is the visual software with stethoscope, hearing aids with in-ear amplifiers, alerting devices and many others, which would assist with the stethoscope in better handling of
the diagnosis of the disease accurately by the deaf physician.

2. RELATED WORK

P.M Thorpe introduced in his article the conventional electronic stethoscope that normally only provide amplification to the heart beat frequency spectrum. He was able to hear any part of this range at the limit of amplification imposed by ear-phone distortion with an ordinary stethoscope.

After a year’s research the Central Acoustics Laboratory of the University of Cape Town developed an electronic stethoscope, which was suitable for his requirements. The solution that he came up with was the lay in the linear transposition of the heart beat frequency to a range within a more sensitive auditory region. This was affected by the amplitude modulation, whereby a high-frequency ‘carrier’ signal was modulated by the low-frequency signal [3].

Therefore, finding the recent best technologies that can be used to assist with the stethoscope should improve the problem significantly.

3. Description of Work

The project was done for the entire semester, in which it was divided into two phrases. The first phase was gathering the background information of the various technologies that would assist the deaf physician to find out the problem accurately and important concepts pertaining to the project, then coming up with the best possible solutions and building prototypes. In the second phase interviews were conducted and based on the results of the participants a solution was obtained.

A few important concepts had to be taken into consideration for this project, which are, stethoscope, deaf physician, vibration, tactile, modification and how the conventional stethoscopes work. According to the Merriam-Webster dictionary, stethoscope can be defined as an instrument used to detect and study sounds produced in the body that are conveyed to the ears of the listener through rubber tubing connected with a usually cup-shaped piece placed upon the area to be examined, deaf physician is a physician that is lacking or deficient in the sense of hearing, vibration can be defined as a periodic motion of the particles of an elastic body or medium in alternately opposite directions from the position of equilibrium when that equilibrium has been disturbed (as when particles of air transmit sounds to the ear), tactile meaning perceptible by touch: tangible and modification means the act or result of modifying something[4].

The concept of how the conventional stethoscopes work should be understood before going into the detail of the project. According to the acoustic heart company, modern stethoscopes like the Littmann Stethoscope consist of a shallow bell-shaped device with a clear stiff diaphragm, connected to the ear pieces by flexible tubing and a hollow metal headset. The chest piece is placed directly on the patient’s skin. As the patient takes deep breaths or the heart beats, sounds are amplified through the diaphragm or bell. These amplified sounds travel through the hollow flexible tubing and headset, finally reaching the examiner’s ears through the tight-fitting earpieces. At this point the examiner can describe and assess the sounds they heard and apply them to their diagnoses and treatment [5].

Therefore, from the background information being researched for the project, we came up with the best solutions of assistive technologies. Many assistive technologies were out there, but some of the assistive technologies were pertinent to the project. The assistive technologies used are visual display devices, alerting devices and hearing aid devices. According to the association of medical professionals with hearing losses, the visual Display software can be used by interfacing a stethoscope with an output jack to a PDA with an audio input jack. Some stethoscopes without an output jack have the
ability to be connected wirelessly to a visual display. Stethoscope App can be used with an iPhone or an iPod, and, Stethographics and StethView can be used with a PDA as shown in Fig. 1.

An overview of the processes that the visual display stethoscope goes through can be shown in Fig 2.

The first high-fidelity prototype is used to illustrate the structure and processes of the visual display stethoscope and alerting device attached to the processor as shown in the diagram. The visual display stethoscope and alerting device in the prototype has been outputted into a processor as shown in the diagram, which can be used to display the results of abnormalities on the display screen by either using the touch screen control or the keypad. There are many other components that are attached to the visual display stethoscope to be used in one way or another such as the backlight, bluetooth, power supply, memory for storing the results and the USB output used to attach other devices.

The prototype was created from the background research information collected in the first phase and by looking at the different design layouts of stethoscope was searched in order to make a prototype by using designs from Texas Instruments and BIOE 414 Instrumentation Projects. From this the Microsoft PowerPoint software was used to create a possible solution of the prototype by using the shapes to display the components, then labeling them and using images from the websites to create the prototype.

According to WIPO, a visual display stethoscope is used in the auscultation of body sounds. The stethoscope is adapted for display, manipulation and analysis of the received body sounds. The present invention as shown in fig.2 includes a stethoscope electronically coupled to a display module. The display module has the ability to display an analog representation of the received body sounds and includes menu keys for selecting among the various functions provided by the stethoscope for manipulation and analysis of the waveform data. These functions include real time analog filtering of displayed waveforms, digital filtering of stored
waveforms, and interval timing between strategic positions in the body sound waveforms. The visual display stethoscope therefore is of significant aid to physicians in the analysis, recognition, and diagnosis of abnormalities, which can be examined via auscultation methods [7].

The alerting device typically provides an amplified and/or visual signal or vibration used to get the attention of the deaf or hard of hearing individual. This device produces a visual (flashing light), tactual (vibration) and/or auditory (very loud) signal that is activated by a loud sound or manipulation of equipment. Therefore, when devising a stethoscope for deaf physician, the alerting device can be attached to the visual display stethoscope processor that can vibrate (tactual) when the range is low, the range is moderate can flash lights (visual), and when the range is high it gives a very loud sound (auditory) according to the degree and type of auscultation. This will notify the deaf physician to the symptoms of the disease and the type of disease.

Figure 2: Electronic Amplified Stethoscope

An overview of the processes and structure of the electronic amplified stethoscope can be shown in Fig. 2.

The second high-fidelity prototype describes an electronic amplified stethoscope, which can be used by the physicians. According to an article entitled “amplified stethoscope options for professionals with hearing loss”, medical professionals with hearing loss who are not current users of hearing instrumentation will achieve success in using one of several stand-alone amplified stethoscopes. In this context, stand-alone amplified stethoscopes refer to battery-operated, electronic stethoscopes specifically designed to amplify body sounds for those health care professionals with hearing loss who are not current wearers of hearing instruments. As stand-alone products, these stethoscopes are not designed to interface with hearing instruments; rather, they are used in the same fashion as traditional stethoscopes with the exception that amplified stethoscopes provides amplification of heart and breath sounds. Each device offers the ability to switch between the two listening modes; the bell mode amplifies the much lower frequency heart sounds whereas the diaphragm mode amplifies breath sounds, which are relatively higher in frequency as compared to heart sounds. The advantage of using this is that the sound is clear and it is sturdy. The disadvantage of this is that it needs battery low alert.

Also, this prototype was created from the background research information collected in the first phase and by looking at the different design layouts of stethoscope was searched in order to make a prototype by using designs from Texas Instruments and BIOE 414 Instrumentation Projects. From this the Microsoft PowerPoint software was used to create a possible solution of the prototype by using the shapes to display the components, labeling them and using images from the websites to create the prototype.

On-phone Interviews were conducted in the second phase of the project. 18 participants had been interviewed which were of 30-60 age range and of male and female genders. These participants were from different universities, which were doctors, residents and lectures. By
doing this interview we were able to understand the problem better and to get solutions in resolving the problem of deafness. The results according to the participants said no because they never encountered a deaf physician or no for instance, when the participant only personally knows of one deaf pediatrician, but his interactions with her have been more social than professional and we are not aware of the technical aspects of her auscultation on physical exam and yes for instance we know some physicians challenged with hearing, which may chose different specialty in medicine either academic or clinical including pathology or surgery and they use stethoscope equipped with sound magnifiers. Also, we know a deaf Endocrinologist, although we never discussed how he dealt with auscultation, he was a brilliant lecturer and could read lips at fairly impressive distances. It was noted that hearing is important in the medical profession because auscultation or hearing helps us to identify heart sounds, find out what kind of murmur the patient has also to find out if patient has too much fluid, if patient has any restriction to airway, hearing bowel sounds is important after a surgical procedure absent sounds could mean dead bowel or a slow bowel. The most important part of dealing with patients and their health care is communication. It is the essence of patient care and diagnosis. Without communicating with your patient the next step in diagnosis (Physical Examination) is poorly directed by the patient’s complaint (s). The instrument that can be used such as a stethoscope that requires hearing is the Doppler device that has an auditory component so that you can hear the flow of blood within vessels (both arterial and venous).

Fig 3: Diagram of a Portable Doppler

Figure 3: shows the result visually after physician has used it on patient

According to the engineering elektromedik, this Doppler illustrated in Fig 3. was used in a medical scenario. We requested to see a patient with distended neck veins, edema of the legs, and rapidly deteriorating mental status. We suspected the heart is not pumping blood adequately to the brain. We placed a miniaturized Doppler transducer on my iDoc over the patient’s chest and image the heart in realtime. Finally, we visualize regurgitation of a leaky heart valve (the blue jet below), and called a cardiac surgeon for emergency surgery to repair it. In such situations, minutes to hours to the diagnosis matter.

A portable device like this would make analog (physical) stethoscopes obsolete, because we could image organs in realtime, as well as listen to them. Today doctors spend years trying to remember the perplexing, barely audible permutations of heart sounds. Realtime digital analysis of acoustic signals would fundamentally change this. Bedside ultrasounds are presently about the size of a laptop, but again that’s too heavy for doctors to carry around, so we simply don’t do it. The iDoc would change that [8].
According to the participants, if you had a hearing impairment the tasks of the physician can be accomplished by using the bedside Doppler/ultrasound devices. These can transmit sound waves into patterns and also demonstrate the abnormalities of structures that cause some of the “sounds” (auscultatory findings) that we elucidate when we listen with the stethoscope. The rapid emergence of ultrasound/Doppler portable technology will see all Physicians carrying a probe that can be attached to their handheld device (eg. I-Phone, Blackberry).

Finally, the participants said that the patients were allowed to see the results on the screen according to the HIPAA act of 1996—“a patient has the right to see their medical record”. We would believe that this would include a visual result produced on a screen.

4. Discussion

During the project we encountered many obstacles such as not finding the possible design solutions for prototyping, how to design the prototype that would be understood to the general population, what are the right solutions to use in terms of the devices and what would be the best solution to use in the project. To overcome these obstacles we had to seek the advice of the professionals as well as the mentor/classmates for ideas about designing the prototype, finding the possible solutions as well as further looking at the websites to get more ideas about the prototypes and the solutions but in the future these obstacles are overcome by looking at the existing projects that were done and solutions that are out there. We learnt that overcoming these obstacles would not be easy.

Also, the limitations of this project were that it was hard to start the project of not knowing what solutions to come up with. Not being able to come up with the proper prototype was a hard task because we had to come up with a solution that should be understood by the general population and should not be technical. There was not enough time to think about prototypes in the second phase.

5. Conclusion and Future Work

In conclusion, the prevalence of deafness among the general population is on the increase, therefore a deaf-friendly stethoscope such as a specialized stethoscope is needed for the deaf physician. The deaf physician or any other doctor has the critical job function of being able to use a stethoscope. The stethoscope is a widely used instrument that is used to detect the abnormalities of the disease. Therefore, we have come up with other solutions of assistive technologies that can assist the stethoscope, such as in-ear hearing aid, visual display stethoscope and the alerting device. These devices aid the stethoscope by showing the results visually on screen, by amplifying the sound so that the deaf physician can hear the sound and use of the alerting device to show the degree of the severity of the disease.

Medical manufacturers can implement these prototypes and devices illustrated in the future in order for the deaf physician to diagnosis the problem accurately.

6. References

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