International Journal of Research in Engineering, Science and Management
Volume-2, Issue-8, August-2019
www.ijresm.com | ISSN (Online): 2581-5792

Hand Assistive Technology for Speech and Hearing Impaired User

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***Abstract*: In the contemporary era, technologies available for deaf and dumb are widely limited with the solution of sign language communication which perquisite tremendous practice for both the individual whether he is victim of dumb or perceiving/seeking for some significant information to persuaded his/her life cycle effectively. It is recommended to being habitat with some scheduled symbol of hand pattern which can be consider and accepted by society as meaningful interpretation in terms of communication. But after dealing with research statistics lies behind technology associated with deaf and dumb we had found in major practice, this proves weird and at some new circumstances it proves obsolete and fails to elaborate expressions and thoughts. This paper impose practical and experimental research has done to overcome this situation by converting sign language to speech language which can be converted in 9 different languages and can be feed to speaker to via medium of smartphone or any android phone. At the same place, for deaf people it gives accessibility to collaborate via smartphone microphone initialize to record speech of second party and recognize the same to deliver it to the hearing impaired individual. This response can be achieved via android software architecture by installing it in the smartphone of the victim. It gives accurate and precise control to make victim independent in case of synchronous communication with world.**

***Keywords*: hand assistive technology, rehabilitation technique for speech impaired and hearing impaired, assistive method using wearable sensor, pattern recognition of sign language, customized pattern of sign language, speech recognition.**

1. Introduction

Healthy hearing and speaking ability is the primary necessary senses of human being to collaborate with actual world in significant way. Hearing is mandatory that gives glimpse to perceive perspective of others while speaking is mandatory for revealing your thoughts to convince other or discuss.

Above all these aspects to persuaded harmonious lifestyle by communicating with each and every one encounter in contact this primary senses plays tremendous role that is not hidden from anyone. Unfortunately, up to some extent aging people are being suffered from malfunction of this senses. Diverse reason and factors are involved in affecting this natural senses of human. Degree of particular impact on this natural sense also varies and can be classify between hearing loss and deafness, whereas hearing loss illustrates loss up to some extent which can be recovered with assistive devices like hearing aid and so on, but in case of deafness people need to strive hard and surgery like cochlear implant is the only option to recover the hearing sense with some positive attributes. According to National Sample Survey (NSS) 58th round held in 2002 had surveyed disability regarding to hearing and found shocking result that hearing disability ranking second among wide range of disability and standing out with almost 6.3% of people out of 63 million people suffering with significant hearing loss, and predicted that number of person with hearing disability per 100000 person was 291 [1]. Speaking impairment can be described and express by inability to speak or pronoun any verbal's or words due to having lack of motor speech disorder which incorporates damage to part of brain related to speaking or having insufficient control on muscle of the mouth, face, or respiratory system corresponds to weak moving of jaws in rhythm for generating speech. Both Apraxia and Dysarthria are widely popular and identical in medical community with traits and symptoms has mentioned here relevant this disorder. Almost about 1 in 12 U.S. children ages 3-17 has had a disorder related to voice, speech, language or swallowing analyzed after holding review for entire year which seems to 7.7% [2]. Sign Language proven to be most effective way of communication for victim suffering with speaking and hearing impairment, since this technique requires fundamental knowledge of sign language by person involved in communication limiting its wider use. Sign language includes a particular combination of finger, palm and wrist to symbolize and elaborate particular digit, alphabets and word which can be recognized to understand meaning. Even this combination varies up to some extent according to some alteration in writing of alphabets which need to be superficial or deep screening by user and victim, so this will make necessity to take this alteration in mind according to writing style of alphabets in diverse region [3]. Outside the human machine interface, hand gestures can't be identified easily, it is an intricate procedure, therefore, requires extreme image processing and sensor interfacing is required [4]. Such methods imply flex sensor to gather data of the hand gestures and movement and attempts to convert American Sign Language in to the speech which need to learn by user/Victim [5]. Albeit, the main problem statement figure out by us, individual with speaking impairment need to undergo through an intricate and convolute procedure at initial stage to communicate efficiently with others know the same language as well. Perhaps, their hard work toward learning ruins and need

to spend more time to compensate the mismatch of language encounters according to region to region. As same happen with person when he is shifting foreign from his native place for short period because he don't know foreign language as well as native and need to use of universal translator which can convert one native language of ones to other by voice recognition and processing speech algorithms of processor. Undoubtedly, our imposed model is advance and takes all this consideration in priority on behalf of deaf and dumb person for harmonious communication by giving flexible and customized access interface of sign language with gloves. It employs numerous sensors and allow customization election of sensor according to convenience of the user, so they can use it in natural way and don't recommended to learn sign language. Furthermore, this add advents of translating speech language of different 9 environment, which eliminate constrains of speech compatibility encounters at global platform.

2. Research Methodology

Hand Assistive Technology for Deaf and Dumb Victim is explained by the following Block-Diagram. The main objective is to develop user friendly design can be consider aesthetic for Deaf and Dumb individual. This method deal by processing and acquiring real time analog output of wearable sensors fascinated in gloves of targeted victim, next converting this details in digital pattern and assigning customized pattern for speech consequences or opt for sign language for universal pattern for speech consequences. This is Hybrid technique/method targeting both deaf and dumb individual to communicate freely with external world. Speaker has introduced for assisting dumb people while bluetooth server has implemented to receive information from remote server connected with by establishing a network.

1. Sensors are the most critical part of this system, since its accuracy and various characteristics are changed according to some atmospheric and environmental changes in climate. Even adding up and subtracting number of sensors alters in stages of complexity of the system. Adding up single similar sensor doubles the possible outcome which can be predicted and assigned using logical calculations for better consequences. Unfortunately, controller are not multi-tasking unit which can deal with all the sensor simultaneously it requires a small and negligible amount of delay between acquisition time of two sequentially programmed sensor, so adding up more sensor will make system bulkier and work with some delay of precious time in terms of milliseconds. Perhaps, this can be neglect since satisfactory and sufficient result has achieved with more number of sensor in this case.
2. Customized design of gloves has been developed along with some small particle of packed metal array to work similar like switched and keyboard to include more particular and specific pattern for wide range output.
3. Real time analog output of the sensors are gathered and analyzed using analog to digital converter which is the inbuilt function of the controller to sample the values of input and is essentially plays a vital role to complete the main purpose of the method.
4. Controller has been employed for real time collaboration of input and output peripherals for creative use of input and output of peripherals, to pattern recognition associated with diverse meaningful quotations since it has the functionality and feature of inbuilt RAM, ROM, Memory and easy serial topology to interface with external Bluetooth hardware.
5. Pattern recognition algorithm has been introduced to provide privileges of customized pattern development, autonomous recognizing and defining most relevant pattern in case of any mismatch of pre-configured pattern associating with speech quotation.

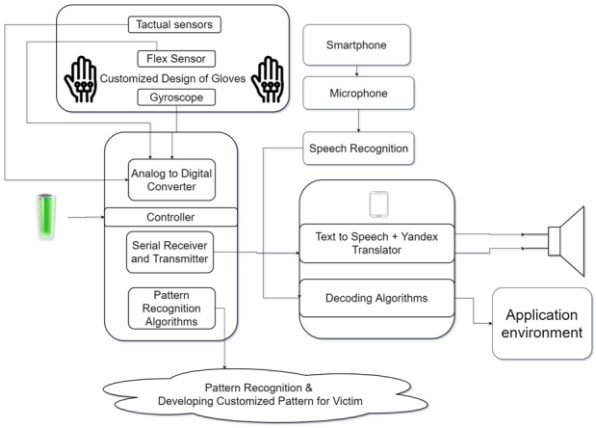

Fig. 1. Block diagram of proposed methodology

6. Android Environment is the heart of all this since it has taken as a medium to decline expense of additional hardware by introducing digital speech processors. Since all these amenities can be found easily in the android base smartphone which can be utilized according to necessity by developing and installing application.
   - Bluetooth client to interface with external Bluetooth hardware connected with controller. It can be easily pair with smartphone and once get paired, connection establishment with application is done by selecting address of this external hardware among entire list.
   - Text to speech algorithms and yandex translator algorithms had been developed, debugged and tested using graphical programming language (MIT App Inventor) gives accessibility to convert text to speech that has send over serially to smartphone via Bluetooth client. It gives privileges to convert same language in another diverse 9 international language for give more flexibility to victim.
   - Consequences of Text to speech feed to speaker via auxiliary cables or the inbuilt speaker of the smartphone can be used according to requirement.
   - Microphone of the smartphone has employed to acquire

and speech of the healthy person and thus decode it to reveal on the smartphone screen via application environment.

A. *Design methodology*

Design of the hand gloves has illustrated clearly in the Figure-2 constitutes of various sensing material like two pair of flex sensor, tactual sensor and gyroscope sensor. To keep this prototype enough aesthetic, reliable and comfortable to wear for victim, this design has considered here with several precautions and scopes. Since design should be prove minimally resistive to natural human mobility.

Flex sensors are placed in such way it stays straight along with individual finger (metacarpal bones and proximal phalanx) and get easily bend according to movement of the fingers to get variations in the value of the flex sensor which can be obtained by the ADC of controller. Simultaneously, tactual sensors are attached at the end of thumb which can be used to touch various point of the palm to generate various randomized signal for meaningful data. Gyroscope need to place on the wrist of the hand or Extensor retinaculum part of the hand to determine the correct angle of the hand which can help in getting more and more amount of possibility in case of combination. For example: if person is performing some activity to transcend some detail, it can be bifurcated using angle to increase maximum possibility of action. So same gesture can be used to iterate multiple meaning with multiple level and cognition of meaning.

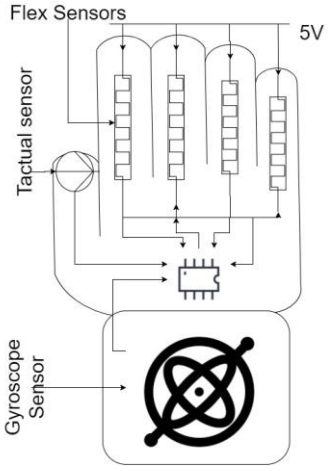

Fig. 2. Architecture of hand gloves

Entire gloves need to cover by the external thin stretchable gloves to ensure that aesthetic appearance of the human hand not going to be unnatural or exotic. So entire hand gloves architecture and all components associate with this device goes in inner portion.

3. Flowchart

Flowchart adumbrates entire procedure in details in chronological order as mentioned below. This technique has divided in two part technically to give better response and to give smooth operations for user/victim. Isolated practice has mentioned for speech impaired and hearing impaired victim respectively.

Assistive procedure and procurement for speech impaired victim has narrated here.

A. *Assistive method for speech impaired*

1) Entire procedure has separated in pre-configuration mode and post-configuration mode. Pre-configuration mode emphasize the cross checking of all the configuration to check whether everything is running well and there is no chance of malfunctioning once it runs. While post-configuration mode is actual working mode in which algorithms of controller works as it behests.
2) Hand Glove Design is the most important considerations since it is undeniable truth that almost all activity of the human are associated with hand only. So engaging hand for verbal communication can disturb our daily chores and routine which is not acceptable or sacrificial for verbal communication.
3) Gloves need to be equipped with good quality sensors which can predict the gesture of the hand without resisting the mobility of the hand, since this requires additional advance design of sensor and gloves for this consideration.

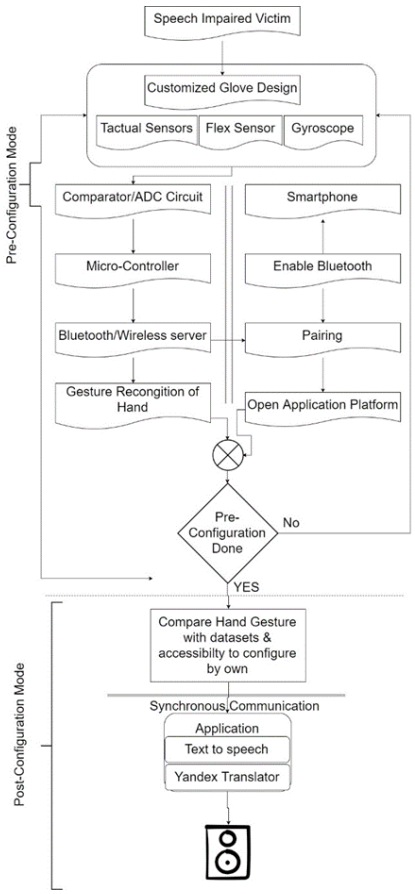

Fig. 3. Flow Chart of Speech impairment assistive method

4) Gloves need to be equipped with good quality sensors which can predict the gesture of the hand without resisting the mobility of the hand, since this requires additional advance design of sensor and gloves for this consideration.
5) Analogue to digital converter has employed here, to convert repetitive real time signals of the sensors in to the discrete signal which can be understood by the controller in order to process and take the decision itself.
6) Microcontroller performs multiple task here, such as interfacing with analogue sensors, controlling Bluetooth peripherals need to be pair with smartphone and most prominent role is recognizing hand gestures to distinguish various symbols and correct meanings.
7) Before controller begins a post-configuration mode, it reassess and determine whether all the requirements are fulfils or not. If not, it attempts to reschedule all configurations.
8) In post-mode configuration, hand gestures are determined which need to store in buffer resistor of controller and then comparing with the already stored ideal datasets for discrimination which can be altered and access by the user/victim according to his/her convenience to approach more flexibility.
9) Synchronous communication is a key factor which need to employ between the Bluetooth peripheral interfaced with controller and smartphone Bluetooth peripheral via pairing and wireless connection establishment.
10) Application environment or android application provided a base of text to speech conversion as a TTS to forward that speech to micro-speakers. As well sane architecture has developed in such way that can be used to convert the same language in to 9 different language so elevate the need of universal translators.

B. Assistive method for hearing impaired

Flowchart narrates a simple method for assisting victim suffering with Hearing impairment. Victim's smartphone can be used here to keep it as simple as possible, experiments are taken on this and 60% to 70 % of accuracy has obtained respectively.

1) Any smartphone which can be approach by the victim can be used, simply application need to install once in that smartphone to perform convoluted calculations that are lying behind the development of the speech algorithms lying to recognition various accents.

2) Application once ask permissions for access microphone, once it granted it can use every time directly without any restrictions.

3) Speech recognition involves convoluted signal calculation for corrigible accent identification which need to be decode in order to make it accurate. The same need to convert in to the Text which can be portrayed on the screen of the victim's smartphone.

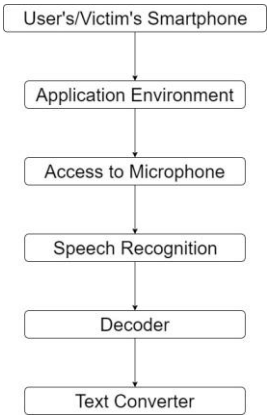

Fig. 4. Flow Chart of Speech impairment assistive method

4. Results

Results are taken here from experimental research, which can be distinguish by either healthy or unhealthy person to justify the accuracy of outcomes.

A. Hand assistive device for speech impairment

This module has designed in such a way that even beginner can have configured motion of the hand according to his/her convenience for elaborate the expression so he don't require additional hours of time to remember the same.

Fig. 5. Hand assisted device for speech impaired

As mentioned in the picture, user need to connect hardware with smartphone using Bluetooth pairing and then pressing switch connect popup the window of selecting the unique Bluetooth ID from given list. Once get connected user can select pattern based on his requirement, and pressing Text to speech converter starts continuously speaking speech performed by the hand for further communication.

B. Hand assistive device for hearing impairment

A Pictorial information illustrates about the working state of the application environment in android platform. As it reveals, pressing button named "Start Listening" begins speech recognition and identification with prompt popup of speech recognizing symbol and gives consequences at the end of entire speaking. This images shares the screenshot of content read loudly from this manuscript only.

The original content was "Android Environment is the heart of all this since it has taken as a medium to decline expense of

additional hardware by introducing digital speech processors. Since all these amenities can be found easily in the android base smartphone which can be utilized according to necessity by developing and installing application.

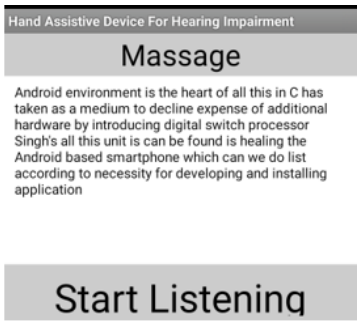

Fig. 6. Hand assistive device for hearing impairment

As depicted in picture, the same content was read loudly several times by changing the speed of reading, it has been noted that slow and clear voice gives almost 90% accuracy while increasing need to compromise with the quality, but anyhow, we can achieve more than 70% accuracy with this environment which is quite good and acceptable for Hearing impairment individual in case he doesn't want any other transplant.

5. Discussion and conclusion

The main objective of this technique/method is to assist speech impaired and hearing impaired person to re-energize them with new spirits so they can live with freedom and independently. This method seems to be unique and novel base on various considerations. This method is combinational solution of both the problems encountered in society which gives almost more than 80% accuracy if used properly. This doesn't require any additional equipment's and components in case of only hearing impairment. Which gives privileges to the deaf people to utilize it to curb his/her disability. Some of the previous attempts imply use of e-speak which converts text to the speech can be fed to speaker for communication but it requires additional hardware like raspberry pi and python base convoluted programming [6] which may prove bulkier some times and also cause to raise its expense ultimately. Text to speech module like encoder (TTS256)-synthesis (SpeakJet) need to imply separately in order to convert text to speech for grabbing solution of this issue [7]. While using this technique this can be embedded inside smartphone and no additional hardware requires. Even these innovative methods require recording of the gestures and speech using several pre-define methods, which can be omitted in this method. This gives extreme facility for speech and hearing impaired victim to get support with low expense and fulfil the requirement of the customized module therefore it can be redesign by user itself due to its easiness.

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