Design of Hearing Aid and Speech Device for People Hearing Dissorders

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***Abstract*—Deafness is a condition in which a person cannot hear due to a disturbance in his hearing organs. In communicating, most of the deaf sufferers only receive hearing aids. WHO (World Health Organization) initiated the Sound of Hearing 2030 by preventing hearing loss by 50% in 2015 and 90% in 2030. The main objective of Sound of Hearing is to develop a comprehensive, inclusive, and sustainable ear care program. Various studies on tools for deafness have been developed. However, this tool is only used to help deaf hearing but not to help speech learning (learn to speak). This research paper discusses a design of hearing aid and speech device for people hearing dissorders. This tool can be a government program, namely supporting a diffable-friendly Indonesia. The tool is designed like a headband, where the headband is composed of a row of vibrating modules that will be connected to the Google Assistant on a smartphone, so that any sound received by the Google Assistant will be sent to the tool to be converted into a vibration pattern. It is from these vibration patterns that a deaf person will get experience in recognizing sounds and learn to speak based on the vibration patterns that are formed. With the design of this tool, that can help deaf people and get support from the community and government to create a diffable-friendly Indonesia.**

Keywords— Deaf, Diffable-Friendly, Headband, Hearing Aid

I. Introduction

Deafness is a disorder in the human hearing organs so that they cannot hear [1]. Deafness in humans occurs from birth and also during growth. If deafness occurs from birth, a person will not have experience in recognizing sounds, so it will be difficult to understand and produce speech. However, if deafness occurs before language acquisition, the communication process is influenced by the basic language acquired during the pre-language period and the way a person can access it to support communication. In communicating, usually, deaf people use hearing aids. For this reason, the World Health Organization (WHO) initiated the Sound of Hearing 2030 by preventing the occurrence of hearing loss by 50% in 2015 and 90% in 2030 [2]. In order to understand sound and speech, deaf people usually use sign language or lip reading. However, hearing impaired users face hearing loss while in the home environment. This in turn results in difficulty in communicating with friends/family, lack of awareness of the surrounding work environment, inability to handle hazards and emergencies, and behavioral problems such as loneliness or depression [3].

In order for hearing aids to be used optimally, a residual population of sensory cells that can be stimulated is needed. This device consists of a microphone, a sound processor, and a circuit of up to 24 tiny metal electrodes that are inserted through the circular window of the cochlea into the scala tympani [4].

The main objective of sound of hearing is to develop a comprehensive, inclusive, and sustainable ear care program. To support the sound of hearing agenda, the Indonesia Inclusive 2030 program was launched in accordance with the SDGs (Sustainable Development Goals). One type of hearing loss that is a priority program for Indonesia Inclusive 2030 is deafness. This is based on WHO records in 2019 at least 466 million people worldwide suffer from deafness and 34 million of them are children. In early March 2018 the WHO had predicted that around 900 million people would experience deafness by 2050 [5]. According to the results of the 1994-1996 national survey, Indonesians experienced hearing loss, namely 18.5 percent or 40.5 million people. Hearing loss in Indonesia reaches 16.8 percent, equivalent to 35.28 million people. Meanwhile, deafness reached 0.4 percent, equivalent to 840 thousand people. Every year more than 5 thousand babies are born with deafness. The data shows that deafness is a very important public health problem so that comprehensive, inclusive, promotive, preventive and sustainable efforts are needed. One of the promotive-preventive efforts of the Indonesian government in overcoming these problems is controlling risk factors, and strengthening. Health Communication, Information and Education (KIE) to the public [2]. Furthermore, researchers have conducted research such as Hou, et al (2019) examining the use of high-precision real-time translators to be used as hearing aids for deaf people. Another alternative, a cochlear implant, can also be used to treat deafness due to damage to the cochlea. However, to be able to do cochlear implantation is very expensive [6].

Until now, various researches regarding assistive devices for deafness have been developed. Some of these devices include a behind the ear device [7], an in-ear speaker/receiver or an ear canal [8, 9], an in-ear device/ITC, an in-ear device/CIC [10,11,12], a cochlear implant [13,14, 15], and GetTalking. However, this tool is only used to help deaf people hear only and not to learn to speak. Therefore, a hearing aid design and learning to speak for the deaf was made to support a diffable-friendly Indonesia. The tool is called a Sanjang which is made like a headband where the headband is composed of a row of vibrating modules. Then the tool will be connected to the Google Assistant on the Android smartphone, so that any sound received by the Google Assistant will be sent to the device and then converted into a vibration pattern. It is from these vibration patterns that a deaf person will gain experience in recognizing sounds and thus a deaf person can learn to speak based on the vibration patterns that are formed.

Various attempts have been made to help deaf people. Several types of hearing aids like in-ear appliance, back-ear appliance, speaker/receiver inside the ear, and cochlear implant have been developed. Some of them may cause distortion, hurting ears, buzzing noise, and for a cochlear implant, which requires a substantial cost. From the technology side, several devices have also been developed, such as a sign to letter translator and speech to text recognition. Sign to letter translator works with a flex sensor that can detect the changes of resistance indicating when a finger is bent [1] and speech to text recognition works with the computer by recognizes a sentence or word and change it into a text. These kinds of device can help the deaf to know what people say to them but not to say to others.

Samuel Krik in his book Educating Exceptional Children (2009) explained the term of deaf refers to the condition of someone who experiences an inability to hear. The deafness can be broadly divided into two parts, deafness in the field of conduction and perception deafness [3].

NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266 contains all crucial elements of the modern computer: RAM, CPU, Wi-Fi, and even a modern operating system and SDK. NodeMCU has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors' specific devices through its GPIOs with minimal development up-front and minimal loading during runtime [4]. By using this microcontroller, make it possible to build a device that can connect to the smartphone and make a communication wirelessly.

A vibrating motor with no axis that can produce a vibration. Can operate in a range of voltage 2-3.6 V. Vibrating motor can be used as an actuator that can create a vibration based on the command that is sent from the microcontroller

II. Methods

The hearing aids and speech device has a shape like a headband, which is used on the head like using glasses. The schematic and design of the system is shown in figure 1.The system is made by three main components such as node MCU as microcontrolle, vibrating motor as an actuator and 3.7 V lipo battery as a power supply for the system.

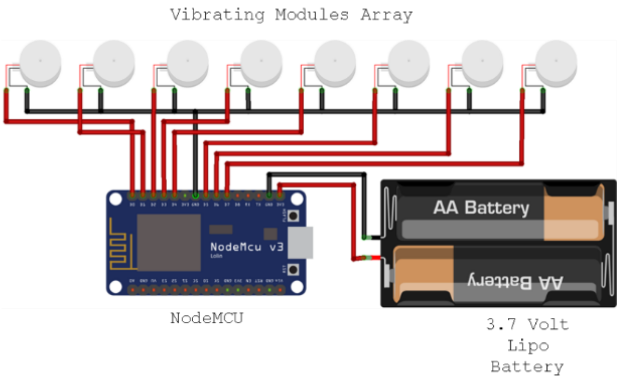

Figure 1. Schematic of Hearing Aids and Speech Device

The hearing aids and speech device using a casing made by the plastic filament. To make this casing, a 3D printer is used. Figure 2 shows the design of the hearing aids and speech device. The design is made by Rhinoceros software.

Figure 2. Design of Hearing Aids and Speech

The vibrating patterns are a pattern that made to distinguish between one-syllabus to another. The sound pattern has 154 syllables, so, at least 8 vibrating motors needed to distinguish them. Using combination without repetition, 8 vibrating motor can create vibrating patterns up to 255 patterns. This amount is sufficient to cover the needs of the sound pattern. The example of vibrating patterns can be seen in figure 3.

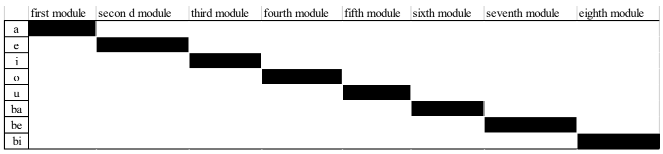

Figure 3. Sound Pattern

III. Results and Discussion

A. Sound Pattern

The device works by changing the sound pattern into a vibration pattern. However, the form of sound is very diverse, so in this study, limitation and determination are determined. The device only changes the human sound, syllable by syllable. The syllable has been determined and can be seen in figure 4. These patterns are made by 21

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consonants and 5 vowels. Therefore 154 syllables are formed.

For vibrating pattern can be connected to the google assistant on the user's smartphone through the Internet. The device will be set to automatically connect into the google assistant when WI-Fi is available for the device. The device can work in two functions.

B. Device as Hearing Aids

As hearing aids, the device works in a few steps:

1. Deaf wearing the device
2. Connecting the device to the Wi-Fi network, so that the device can connect to the internet and the google assistant on deaf smartphone
3. The sound source (other people) starts saying, other people sound caught by google assistant on the deaf smartphone.
4. Google assistant change the sound pattern based on the syllabus to become text
5. Text result sent through the internet to the device
6. The device convert the text accepted to become a vibrating pattern

The vibrating module, vibrate according to the pattern can be shown in figure 4.

1	a	e	i	o	u					
2	ba	be	bi	bo	bu	ab	eb	ib	ob	ub
3	ca	ce	ci	co	cu					
4	da	de	di	do	du					
5	fa	fe	fi	fo	fu	af	ef	if	of	uf
6	ga	ge	gi	go	gu					
7	ha	he	hi	ho	hu	ah	eh	ih	oh	uh
8	ja	je	ji	jo	ju					
9	ka	ke	ki	ko	ku	ak	ek	ik	ok	uk
10	la	le	li	lo	lu	al	el	il	ol	ul
11	ma	me	mi	mo	mu	am	em	im	om	um
12	na	ne	ni	no	nu	an	en	in	on	un
13	pa	pe	pi	po	pu					
14	ra	re	ri	ro	ru	ar	er	ir	or	ur
15	sa	se	si	so	su	as	es	is	os	us
16	ta	te	ti	to	tu	at	et	it	ot	ut
17	wa	we	wi	wo	wu					
18	ya	ye	yi	yo	yu					
19	za	ze	zi	zo	zu					

Figure 4. Sound Pattern

C. Device as hearing and Speech Aids

As hearing aids, the device works in a few steps:

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6. The device convert the text accepted to become a vibrating pattern

   The vibrating module, vibrate according to the pattern on the figure 4.

As a hearing aid, device works in a few steps:

1. Deaf wearing the device.
2. Connecting the device to the Wi-Fi network, so that the device can connect to the Internet and the google assistant on deaf smartphone.
3. Deaf accompanied with the instructor, try to say the word with mouth movements imitating the instructor.
4. The deaf feels the vibration pattern generated by his own voice while matching the spoken word with the text received by the google assistan

IV. Conclusion

In this paper, we have been succesfully design of hearing aid and speech device for people hearing dissorders. A hearing aid and speech device for people hearing dissorders was designed and developed. With the algorithms used, it gave better hearing improvements with surrounding sounds, reference for learning to speak. It proved that our design provides a voice replacement experience for the Deaf. There are still deficiencies in hearing aids and learning to speak. The following are areas where hearing aids and learning to speak for the deaf can be further researched, developed, and tested:

1. Currently, the sound patterns used are still limited and based on the author's design. There needs to be further research on the sound wave patterns released by humans.

2. The government's role is needed to develop the headband, to support Indonesia Inclusive 2030 according to the SDGs

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