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Implementation of web application based on Augmentative and Alternative Communication (AAC) method for People with Hearing and Speech Impairment

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***Abstract*— One of the most important things that humans need in their life is communication. Communication helps to spread knowledge, information and different forms of relationships between people. Unfortunately, millions of people around the world are unable to enjoy this blessing. With this in mind, the number of communication devices, applications, systems, strategies and tools that replace or support natural speech is increasing rapidly. This paper describes an AAC software we developed that helps both disabled children and adults to communicate easily with other people especially in office work, school or social gatherings. To use this software, users should input a sentence and it will converted to audio speech using built-in voices for male or female. In addition to that, it can convert voice that received by microphone into text and display it on the screen for deaf people to read.**

***Keywords*— Assistive Application, AAC, Speech Synthesizer, Speech Recognition, C# Programming**

I. INTRODUCTION

According to a report surveyed by the Korea Employment Agency for Persons with Disabilities in 2018, the number of registered persons with disabilities in South Korea is increasing year by year, and among the 15 types of disabilities, there are 322,324 persons with speech and hearing impairments, which is 12.7% of the total [1].

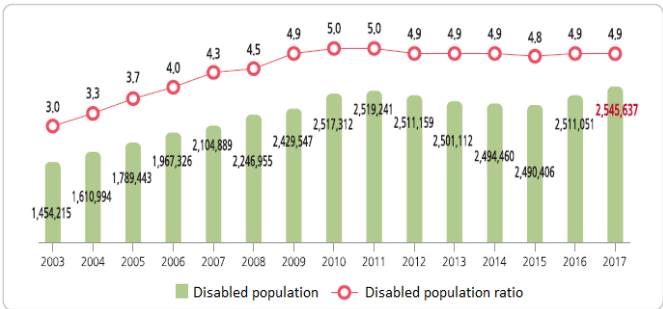

Figure 1. Status of Registered Disabled in South Korea [1]

Hearing impairment, also known as hearing loss, is a condition in which people cannot completely receive sounds through their ears and Speech impairment, also called communication disorder, or voice disorder, is a condition in which people have trouble forming sounds. Symptoms of hearing/speech impairment include not only health such as hearing loss, stuttering, elongating words, problems with articulation, but also mental symptoms such as visible frustration when trying to communicate or taking frequent pauses when trying to communicate, weakness and so on.

To successful communication requires the efforts of all people involved in a conversation. Even when the person with hearing/speech impairment utilizes active communicate method such as hearing aids, it is crucial that others involved in the communication process consistently use good communication methods.

In this paper, we implemented web application, which based on Augmentative and Alternative Communication (AAA) method. AAC involves different types of communication methods that supplements (augments) or replaces (provides an alternative to) the usual methods of speech and/or writing where these are impaired or insufficient to meet the individual's needs [2]. These methods include sign language, pictures, symbols, communication board, "yes" or "no" choices.

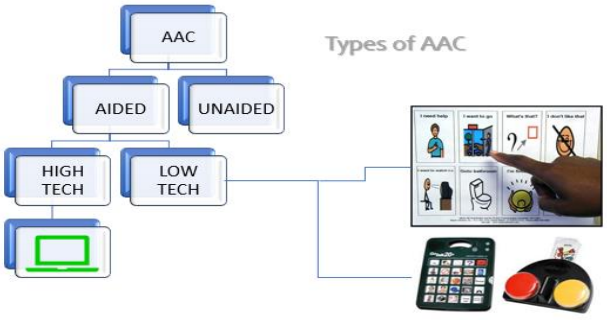

Figure 2. Types of AAC

The developed web application uses speech recognition technology to convert speech into text into what people with hearing impairments say. In addition, voice synthesizer converts texts written by people with language disabilities into audio voice, and supports voice separately for men and women, considering user's gender. It is not only can be used as a convenient communication tool, it can also be used as a therapeutic tool for natural speaking by people with hearing or speech impairments.

II. Related Works

Obviously, healthcare has been undergoing a rapid and dramatic transformation. With the introduction of communication technologies, there is an excellent increase in providing high-quality medical services. Several well-known healthcare software companies such as Oxagile [3], NextGen Healthcare [4], Macademian [5] and others are also trying to develop efficient and helpful medical and AAC apps to help patients. Some of the other similar AAC apps and tools include InterpreterGlove [6], Prologue2Go [7], QuickTalk AAC [8] etc.

By doing some research, we have found out that many of these assistive software are for mobile devices, and are usually for nonverbal communication methods. We have developed our software with couple of additional functions to speed of the conversation process because many users want comfort and speed since they use assistive apps on a daily basis regularly. Furthermore, the amount of AAC assistive software for computers are less nowadays, and they only provide quite limited ways for deaf and dumb people. In order to solve this issue, we have tried to create an effective and high-quality application considering all the current problems related to AAC and healthcare programs.

III. Main Functions and User Interface

We developed web application using Microsoft Visual Studio. After making a clear-cut software development plan, we started the project with C# language. Our application has English used as its primary interface language; however, we are working on other languages mainly Korean, Uzbek and Russian. The reason behind why we chose English language for now is that it has largest number of people who can communicate in English whether native or not. In order to run the software, a system must have compatible .NET Framework 4.5 pre-installed. If not installed yet, the user can turn it on in Windows Features or download and install it from Microsoft website. Our application can run on both 32-bit and 64-bit operating systems.

A. *Main Functions*

Developed application has Speech Recognition feature using ASR and dictation grammar to take the input of human speech, interpret it, and transcribe it into text. This feature used when a person wants to talk to the patient with hearing impairment.

Along with that, another core functionality of the software is Text to Speech Synthesizer. When a patient with speaking disorder tries to communicate with others, he or she can take the advantage of this feature easily. A text-to-speech (TTS) system of application converts normal language text into speech; rendering symbolic linguistic representations like phonetic transcriptions into speech. According to the gender, info of the user using the program, which is fetched from the database, corresponding gender (that is male or female) voice is produced.

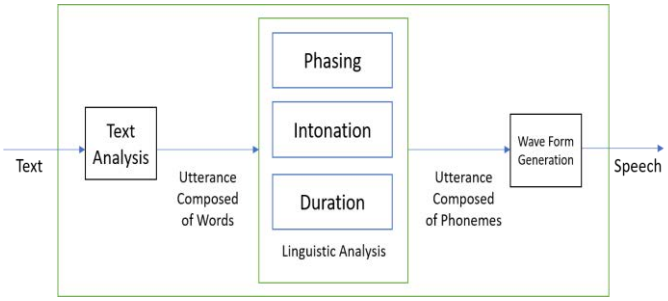

Figure 3. Text-to-Speech Process Diagram

Other features include automated replying and quick reply.

B. *User Interface*

We have tried to make the program as user-friendly as possible. Considering that majority of the users of developed application are supposed to be patients or disabled people, it has to be easy to use and easy to understand.

The Figure 4 shows a form that displays the results of text-to-speech function. The user must type what he or she wants to say and then click Speak button next to it. Depending on the gender of the user, application speaks that text using built-in voice libraries.

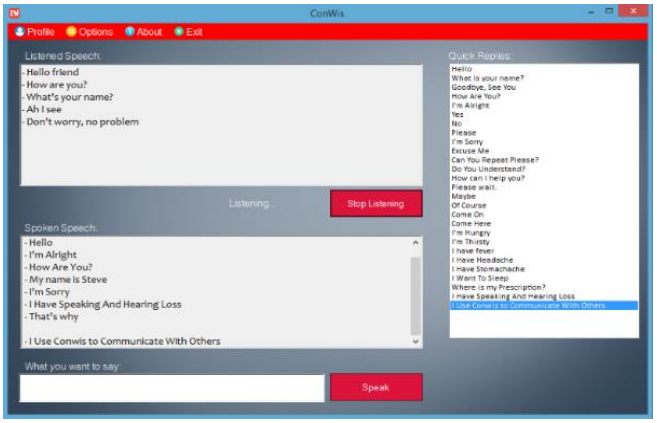

Figure 4. The main interface of developed application

The main window is where all the features come to work. There is a panel on the left upper corner of the interface labelled with Listened Speech. This is where a result of speech recognition engine displayed. To start listening for voices, a red button with the text “Start Listening” have to click. From this on, a program continues to pick up voices it hears and using ARS, it processes the sounds, converts them into readable text, and shown on the panel. To stop the program from listening, the same button, now labelled “Stop Listening”

is click and speech recognition action terminated.

If a patient with speaking disability wants to speak or reply, he/she can enter some text on a textbox at the bottom of the main window and press the Speak button. Then, program call the function to convert the input text to sound, and finally the user hears the converted voice. The log of user's spoken sentences is stored on the Spoken Speech panel.

In addition, the quick reply feature allows user to select frequently used English expressions. This saves time for the user from typing common phrases. The menu bar on the top of the interface provides some necessary functionalities such as modifying the user info and setting up Automated Replies, which customized by the user's preferences. Other tabs include Options to change the theme of the program, About for displaying developed application details and Exit button for closing the program.

In order to speed up the communication process, we have added 2 important functionalities, they are "quick reply", and "automated reply" functions. The sentences in "quick reply" bar are fixed but the user can easily modify "automated reply" database and add different types of answers for several questions.

The user wants convenience and communicate as quickly as possible. By filling up the Automated Replies section with his or her own questions and answers, patients can speed up their interacting process and save time by avoiding repetition in typing. Example entries include details about user, or his or her likes and dislikes, etc.

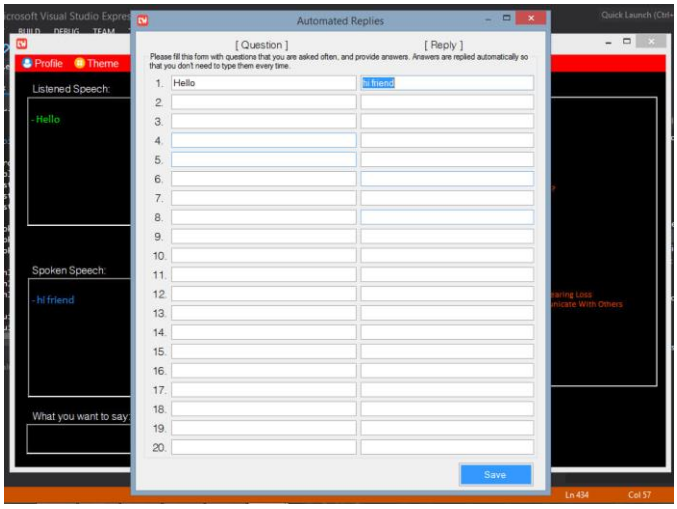

Figure 5. Automated Replies entry form

The first time a user starts the program, it asks for registering the patient with main credentials such as full name, gender, birthdate and location. All of this information will be stored offline and used in automated replies to speed up the conversation process.

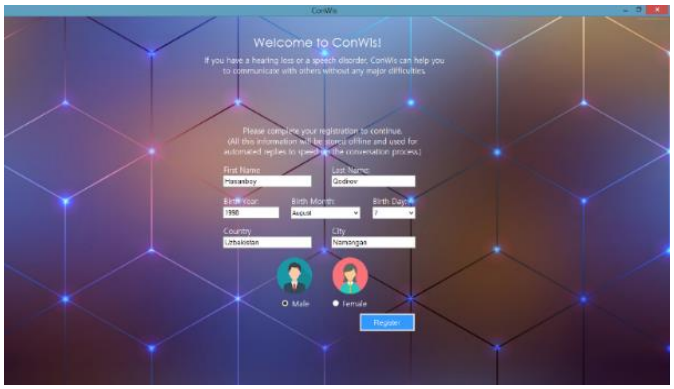

Figure 6. Registration window

If the user wants to change this personal detail, he or she can do it by opening the "Update Profile Info" window. We tried to develop the main menu very easy and comfortable to navigate. There is also Log Out option, just in case the user wants to terminate his or her account. This will delete all the personal information belonging to the user from the software database.

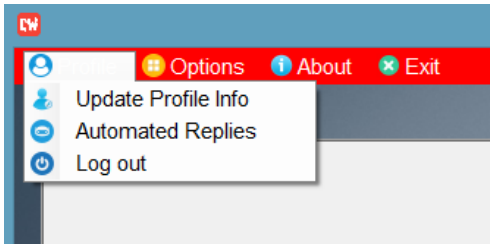

Figure 7. The main menu bar

About menu contains information such as developed application logo, description, current version, supported operation systems, compatible framework, language and developers' names and contact details.

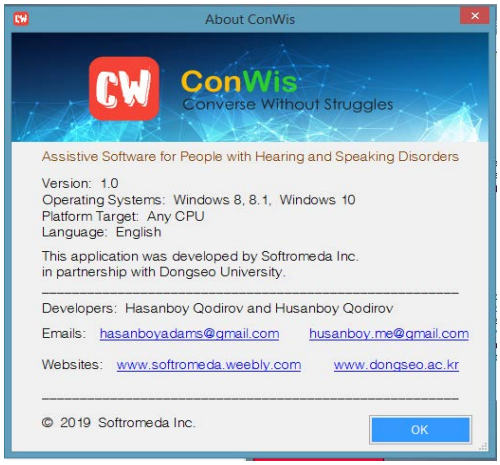

Figure 8. About menu

IV. EXPERIMENTAL RESULTS

We have tested the program several times by simulating the conversation of two people; a person who has no hearing or speaking disorder and a person who cannot speak. We have

used Astro A20 headphones for testing processes and got satisfactory results. Below is a result of one of our experiments. In this test, we detected one small mistake in the accuracy. As you can see on the last detected speech in the Listened Speech section, the word ‘cloud’ was mistakenly recognised as ‘clout’. Other than that, the program is working nominally. It is worth to mention that less background noise, clear accent and pronunciation, along with high quality microphone are essential for accurate results.

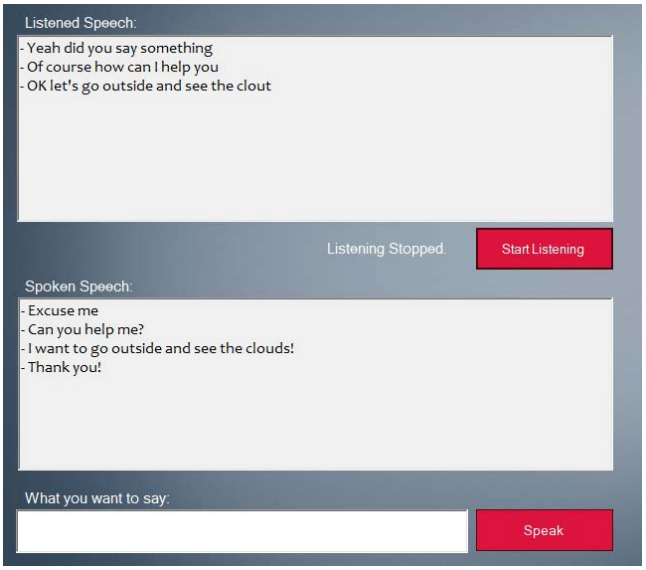

Figure 9. Experimental result for accuracy

As we have mentioned earlier, the program is now using built-in speech recognition library of Windows operating system. Later on, we are planning to upgrade it to more powerful speech recognition APIs such as Google Speech API or Amazon’s Alexa Voice Service.

V. CONCLUSIONS

To sum up, not being able to speak or listen is not the same as having nothing to say. Children, teens and adults who cannot communicate with other because of some disabilities can use this AAC app for Windows Operating Systems as a daily communication tool.

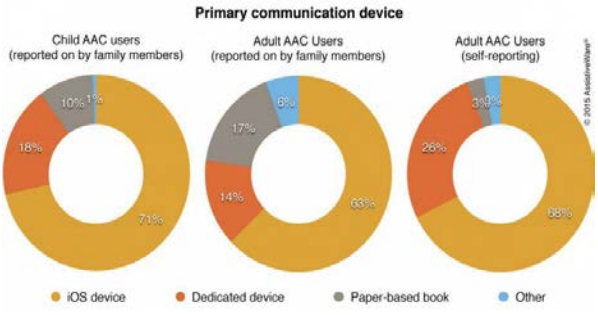

Figure 10. Primary communication devices [9]

Although there are many mobile healthcare apps available nowadays, we believe that users should also have many options for choosing different types of healthcare programs developed for various devices. We feel proud and satisfied if we become providers and developers of high quality and useful applications of healthcare technologies.

In the future, we will develop web application for two most common mobile platforms such as iOS, Android because many patients or users prefer to use medical apps on their smartphone. We believe that medical apps make a life of patients and physicians more convenient.

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