SpeechAid: Self-treatment system for individuals with Speech Disorder via mobile application

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1. INTRODUCTION

Speech disorder as a form of communication disorder can affect nearly every aspect of human life. Among various types of speech disorders, stuttering and dysarthria are most common. Stuttering or stammering means the disruption in the flow of speech due to involuntary repetitions and prolongations of sounds or syllables as well as involuntary pause or break in speech [3]. Approximately 1% of adult population are affected by stuttering [8]. In West Africa, the prevalence rate of stuttering is highest, reaching 5%, 6% and even over 9% in some populations [9]. On the other hand, dysarthria is a motor speech disorder in which the muscles of the mouth, face and respiratory system may become weak after stroke or other brain injuries causing limited tongue, lip and jaw movement and poor articulation of phonemes [7]. According to the World Health Organization, 15 million people suffer stroke worldwide each year [2]. Over 19% of the survived patients have trouble in speaking due to various motor speech disorders including dysarthria. Availability of Speech and Language Pathologists (SLP) compared to the number of patients is so low that the treatment cost often goes beyond reach for poor and middle-class patients from underdeveloped countries. Hence, an individual virtual speech therapist can positively assist the patient through self-treatment.

State of Mobile, 2013 - infographic created by AF-Studio.pl and Super Monitoring.com shows that 56% of all people on earth has a smartphone while 80% of time on mobile is spent inside apps [4]. Our idea is to use this emerging mobile technology to help people deal with speech disorder in a low-cost(free) and user-friendly way. In this paper, we propose a virtual speech therapy system, **SpeechAid**, which can help a patient suffering from stuttering or dysarthria improve his/her speaking ability through various training and exercises widely accepted by SLPs.

2. BACKGROUND AND RELATED WORK

Advances in computer technology have led to the creation of various specialized devices called augmentative and alternative communication (AAC) devices that help individuals with no or poor speech overcome their problems. Currently, there are some mobile applications like DAF Professional, Stutter Rater etc. which implement various techniques like Delayed Auditory Feedback etc. to reduce stuttering. For teaching users better pronunciation and phonemes, some articulation apps are also available which provide various

words for practice as well as say those aloud. Again regarding dysarthria, we found some apps which provide lip and tongue exercises in text. A number of books and DVDs are also found in the market for these exercises.

3. APPROACH AND UNIQUENESS

SpeechAid system accumulates all these aforementioned popular techniques and offers a complete and effective package to guide the users along the path to overcome speech disorder from the scratch. Users can start practicing with a single word and then gradually practice a long, tongue twisting sentence alongside applying DAF technique when they find it necessary. Besides, different kinds of lip, tongue and jaw movement videos are also provided in the app to assist them like a virtual therapist. Moreover, studies show that while some stutterers show substantial reductions in stuttering using different techniques, others improve only slightly or not at all [5]. In this context, support groups and self-help movement are gaining popularity as this serves as a shared forum within which people can access resources and support from others facing the same challenges [1]. Here,**SpeechAid** can also come in help as it provides a section for online user forum.

3.1 Mobile Application

The mobile application can be used without internet service. It has two subsections called StutterAid and StrokeAid(see Figure 1).

3.1.1 Option 1: StutterAid

This section is designed for stutterers with features like

- **Delayed Auditory Feedback:** This section provides the traditional DAF technique where user can hear his/her own voice in the headphone with suitable delay chosen by the user.

- **Word Rephrasing:** Words divided in different syllable groups will come to screen one at a time. User can listen to the actual pronunciation of the word as well as record his/her own rephrasing and compare the recording to check how close it is to the actual pronunciation(see Figure 2). There will be an option to show automatic rating of the user's rephrasing in future versions.
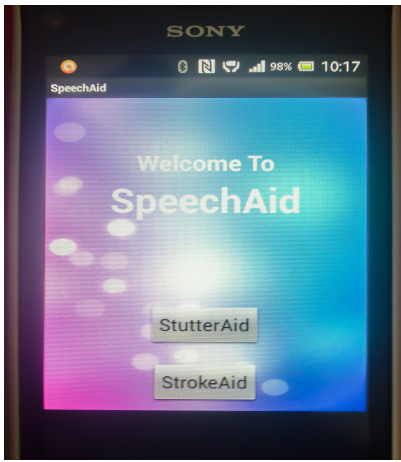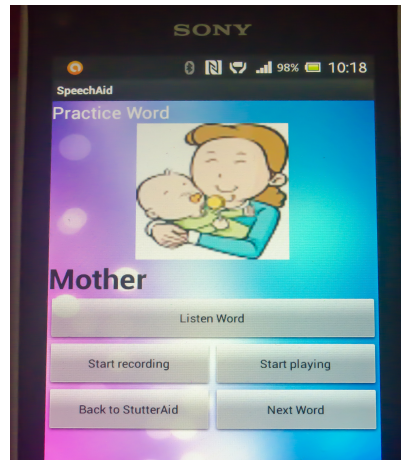
Figure 1: Home Page

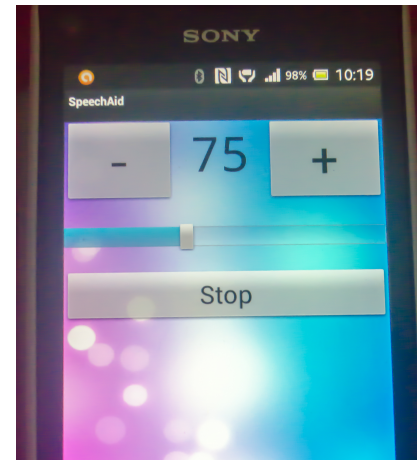

Figure 2: Word Rephrasing

Figure 3: Metronome

- **Continuous Speaking Practice:** It is evident that most stutterers face problem in speaking continuously while they do not stammer pronouncing a single word. Hence, in this section some tongue twister sentences are given. Practicing these regularly can enhance lip and tongue movements and reduce breaks in flow of speech of the users. Recording options are also provided here.

- **Practice with Metronome:** Studies show that people do not stutter when they speak in a rhythmic tone for example, while singing a song, reciting a poem etc. SLPs often advice stutterers to practice speaking at a slow rhythm and then increase the speed. In this section, a 'tick' sound is provided and user can practice reading a passage or speaking to another person in each tick. The speed of the tick can be controlled by the user(see Figure 3).

- **Add Word:** People who stutter often has some particular words commonly called 'Feared Words' which they find hard to pronounce while they do not face problem speaking other normal words. In this section, user is allowed to add his/her feared words which he/she can later choose to practice from 'Word Rephrasing' option.

3.1.2 Option 2: StrokeAid
This section is designed to help people suffering from motor speech disorder like dysarthria due to stroke or other brain injuries. If the person is unable to operate the mobile device himself, any of his family members or companions can guide him throughout the process. This can be a great help to the people who cannot have access to individual SLP due to financial problem or unavailability of experts in underdeveloped countries. The main features are:

- **Lip & Tongue Exercise:** A number of lip & tongue exercises widely approved by SLPs is shown in text along with video of that particular exercise. Some videos are embedded within the app and some canl be streamed from Youtube if the internet connection is available. This is done in order to reduce the size of

the app. Moreover, SLPs often suggest practicing in front of a mirror; so here, we offered an option to turn on the front camera of the device to show the user how he/she is doing the exercise as if there were a mirror in front of them.

- **Syllable Rephrasing:** It is found that people undergoing stroke and brain injuries cannot pronounce a single syllable let alone the whole word. This option gives user chances to practice the basic syllables, disyllables and tri-syllables repeatedly until he/she can properly pronounce it.

- **Word Rephrasing** and **Add Word:** These two options are same as in StutterAid section.

On the Wireless RERC's (2010) survey, stroke respondents suggested that bigger buttons, bigger text, bigger screens and text-to-speech recognitions would make mobile devices easier to use for them [6]. We have taken special care in designing StrokeAid section according to these suggestions.

3.2 Online Forum
In the mobile application, each user can create his/her own account using which he/she can get access to the online forum if internet connection is available. Here users of the app all over the world can share their problems and find solutions from each other like an active social networking group. Occasionally lectures from professional SLPs will also be provided in the forum to encourage users.

4. RESULTS AND CONTRIBUTIONS
Android 4.4 - API Level 19 is used to build the prototype of the application. Sony Xperia L is used as the application's running device. Two people with stuttering prolem and another two having dysarthria were requested to use our app and give feedback. This usability test result showed that **SpeechAid** has potential of helping people reduce speech disorder in a effective and user-friendly way(see Table 1).

5. FUTURE WORKS

Table 1: Usability test result of **SpeechAid**

	Usability Testers			
	1	2	3	4
DAF	good	good	not good	moderate
WR	good	good	good	good
CS	good	good	good	good
Met	good	good	good	good
AW	moderate	moderate	moderate	good
Exc	good	good	good	good
SR	good	good	moderate	good

DAF= Delayed Auditory Feedback, **WR**= Word Rephrasing, **CS**= Continuous Speaking, **Met**= Metronome, **AW**= Add Word, **Exc**= Lip & tongue Exercises, **SR**= Syllable Rephrasing

In future, we intend to build the app for other languages apart from English as well as in other operating systems like iOS and Windows Phone.

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