International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

General Article

Shwas: A Smartphone based Augmentative and Alternative Communication (AAC) System which Converts Breath into Speech

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Accepted 01 Nov 2014, Available online 05 Nov 2014, **Vol.4, No.6 (Dec 2014)**

Abstract

To make Augmentative and Alternative Communication (AAC) devices accessible to everyone, I present Shwas. AAC device is used by people suffering from developmental disabilities like cerebral palsy, intellectual impairment, autism, ALS, etc. The life expectancy of such people is expected at 20 years below average, mainly due to absent or inadequate communication. The AAC devices which are available now are expensive and heavy. This paper presents a novel technique of communication using the smartphone. Shwas is a smartphone application which converts the breath of the user into speech. The application uses breath input in the form of Morse code and converts it into audible speech or visible text which can then be used for communication.

Keywords: *aac, mobile, augmentative and alternative communication, morse code.*

1. Introduction

Augmentative and alternative communication (AAC) is an umbrella term that encompasses the communication methods used to supplement or replace speech or writing for those with impairments in the production or comprehension of spoken or written language. AAC is used by those with a wide range of speech and language impairments, including congenital impairments such as cerebral palsy, intellectual impairment and autism, and acquired conditions such as amyotrophic lateral sclerosis and Parkinson's disease. AAC can be a permanent addition to a person's communication or a temporary aid.

People with severe speech or language problems rely on AAC to supplement existing speech or replace speech that is not functional. The different types of AAC systems are as follow:

1.1 Unaided communication systems

Unaided AAC systems are those that do not require an external tool, and include facial expression, vocalizations, gestures, and sign languages and systems (Mirenda, 2003). Informal vocalizations and gestures such as body language and facial expressions are part of natural communication, and such signals may be used by those with profound disabilities. More formalized gestural codes exist that lack a base in a naturally occurring language.

1.2 Aided communication systems

An AAC aid is any "device, either electronic or non-electronic, that is used to transmit or receive messages" (Beukelman, 2005); such aids range from communication books to speech generating devices. Since the skills, areas of difficulty and communication needs of AAC users vary greatly, an equally diverse range of communication aids and devices is required.

Shwas was created to overcome these challenges and be an affordable, light and portable alternative to the existing AAC devices. Shwas is a smartphone application which converts the breath of the user into speech. The application uses the breath of the user as the input, which needs the breath to be in the form of Morse code. The application interprets two distinguishable exhales as Morse codes (short exhales are dots and long exhales are dashes) and converts them into words and sentences. Breath as a medium of interaction between the user and the device is a unique approach of solving the problem of inability to move which is very common among the patients of diseases like ALS.

2. Morse Code

Morse code is a method of transmitting text information as a series of on-off tones, lights, or clicks that can be directly understood by a skilled listener or observer without special equipment. The International Morse Code encodes the ISO basic Latin alphabet, some extra Latin letters, the Arabic numerals and a small set of punctuation and procedural signals as standardized sequences of short and long signals called "dots" and "dashes", or "dits" and "dahs". For emergency signals, Morse code can be sent by way of improvised sources that can be easily "keyed" on and off, making it one of the simplest and most versatile methods of telecommunication. The most common distress signal is SOS or three dots, three dashes and three dots, internationally recognized by treaty.

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Each character (letter or numeral) is represented by a unique sequence of dots and dashes. The duration of a dash is three times the duration of a dot. Each dot or dash is followed by a short silence, equal to the dot duration. The letters of a word are separated by a space equal to three dots (one dash), and the words are separated by a space equal to seven dots. The dot duration is the basic unit of time measurement in code transmission. For efficiency, the length of each character in Morse is approximately inversely proportional to its frequency of occurrence in English. Thus, the most common letter in English, the letter "E," has the shortest code, a single dot.

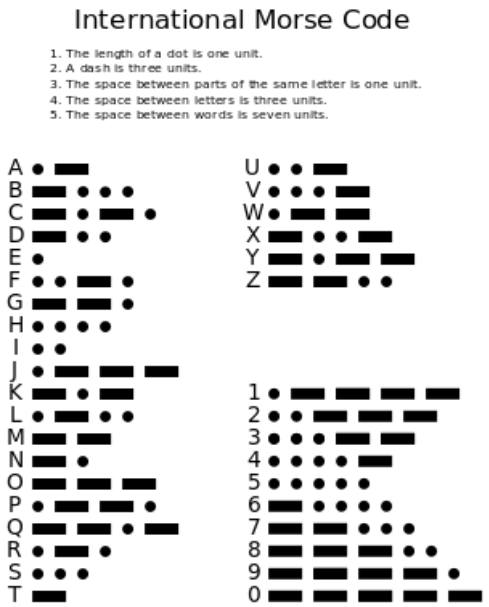

Fig.1 Chart of the Morse code letters and numerals

International Morse code is composed of five elements

- short mark, dot or "dit" (·) — "dot duration" is one time unit long
- longer mark, dash or "dah" (–) — three time units long
- inter-element gap between the dots and dashes within a character — one dot duration or one unit long
- short gap (between letters) — three time units long
- medium gap (between words) — seven time units long

Morse code has been employed as an assistive technology, helping people with a variety of disabilities to communicate. Morse can be sent by persons with severe motion disabilities, as long as they have some minimal motor control. An original solution to the problem that caretakers have to learn to decode has been an electronic typewriter with the codes written on the keys. Codes were sung by users; see the voice typewriter employing morse or votem, Newell and Nabarro, 1968.

Morse code can also be translated by computer and used in a speaking communication aid. In some cases this means alternately blowing into and sucking on a plastic tube ("sip-and-puff" interface). An important advantage of Morse code over row column scanning is that, once learned, it does not require looking at a display. Also, it appears faster than scanning. People with severe motion disabilities in addition to sensory disabilities find it easier to communicate using Morse code.

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M   O   R   S  E          C   O   D  E
-- --- ·-· ··· · (space) -·-· --- -·· ·
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Fig.2 The word "Morse Code" represented in Morse code format.

3. Design

The design for Shwas leverages the on-board microphone for breath input (located towards the bottom of the device). The input through the microphone is continuously monitored to differentiate between short exhales (which correspond to "dit") and long exhales (which correspond to "dah"). The input of the microphone is passed through a low pass filter to eliminate any other noise that might be entering the microphone.

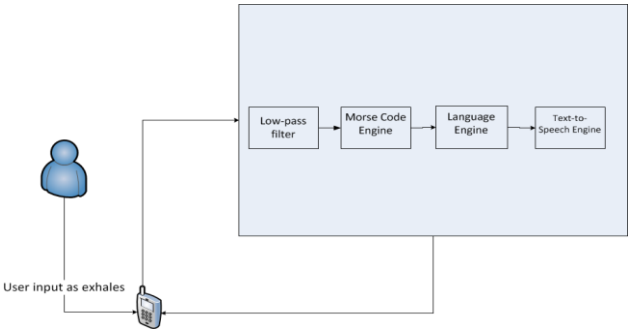

Fig.3 Shwas Architecture

As seen in Fig 3, the microphone input passes through a low pass filter to identify exhales into the microphone and to eliminate all other noises. These exhales are passed through a Morse code engine which converts the exhales into corresponding Morse code based on the amplitude and frequency.

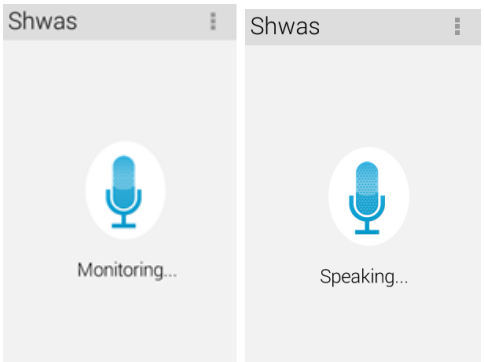

Fig.4 Screenshots of the Shwas app.

The job of the Morse code engine is to segregate the exhales into dots and dashes (Fig. 1) based on the duration of the exhales and the duration between two consecutive

exhales. This is the most important step of the process. The output of the Morse code engine goes to the Language Engine which then converts the Morse code into corresponding alphabets, words, numbers and sentences. This is done using the standards set by the International Telecommunication Union(ITU).The output of the Language Engine is in string format, which is then passed on to the text-to-speech engine present in Android which then converts the text into speech which is read out aloud from the smartphone. It is also very important that the users are allowed to customize how the voice sounds since this is built to help them better express themselves. Hence, they will be allowed to customize the voice of the output out of the various options that will be made available to them based on their preferences.

Conclusions

This paper presents Shwas, an Android application which makes Augmentative and Alternative Communication (AAC) devices accessible to everyone. It converts the breath of the user into audible speech. This is a novel technique for communication and the possibilities are limitless. Shwas has a long way to go in terms of truly unlocking its potential. With the landscape of mobile operating systems continuous changing, it will one day be possible to even receive calls and use Shwas as a means of communication.

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