Notice of Violation of IEEE Publication Principles

"A Voice Input Voice Output Communication Assists in Favor of People with Harsh Verbal Communication Destruction"
by M. Babu and V. Dhilip Kumar
in the Proceedings of the International Conference on Information Communication and Embedded Systems, February 2014

After careful and considered review of the content and authorship of this paper by a duly constituted expert committee, this paper has been found to be in violation of IEEE's Publication Principles.

This paper is loosely paraphrased copy of the paper cited below. The original text was copied without attribution (including appropriate references to the original author(s) and/or paper title) and without permission.

Due to the nature of this violation, reasonable effort should be made to remove all past references to this paper, and future references should be made to the following article:

"A Voice-Input Voice-Output Communication Aid for People with Severe Speech Impairment"
by Mark S. Hawley, Stuart P. Cunningham, Phil D. Green, Pam Enderby, Rebecca Palmer, Siddharth Sehgal, and Peter O'Neill
in the IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 21, No 1 January 2013, pp. 23-31

A VOICE-INPUT VOICE-OUTPUT COMMUNICATION ASSISTS IN FAVOR OF PEOPLE WITH HARSH VERBAL COMMUNICATION DESTRUCTION

Mr.M.Babu.,B.E
ME Computer science and engineering, final year
Dhaanish Ahmed College of engineering
Chennai - 601301
Babu_compengg@hotmail.com

Mr.V.Dhilip kumar, B.Tech.,M.E.,MISTE.,
Asst.Professor Department of Information Technology
Dhaanish Ahmed College of engineering
Chennai - 601301
dhilipkumarit@gmail.com

***Abstract* — an actual VOICE INPUT VOICE OUTPUT Correspondence Help identifies the actual disordered talk from the person as well as develops communications that are changed into artificial talk. Tests demonstrated this technique works within producing great acknowledgement overall performance (mean precision 98 percentage) upon extremely disordered talk, even if acknowledgement perplexity is actually elevated. The actual VOICE INPUT VOICE OUTPUT Communication Assists (VIVOCA) had been examined inside an area test through people with reasonable in order to serious dysarthria as well as verified that they'll utilize the gadget to create intelligible talk result through disordered talk enter. The actual test outlined a few problems that restrict the actual overall performance as well as user friendliness from the gadget whenever used within actual utilization circumstances, along with imply acknowledgement precision associated with 85 percentages within these types of conditions. Once after receiving the clear speech in English as input, the same can be translated to any other language as an output, with the same meaning as it is in input. These types of restrictions are going to be tackled within long term function.**

Keywords* — *Augmentative conversation, automated talk acknowledgement, dysarthria, tone of voice result communication help

I. INTRODUCTION

VOICED vocabulary conversation is really a basic element in standard of living, however as much as 1. 3% from the populace can't make use of organic talk dependably in order to connect, particularly along with other people [1]. For example, the actual talk of individuals along with moderate in order to serious dysarthria - the most typical talk condition impacting 170 for each 100 000 associated with populace - is generally unintelligible in order to not familiar conversation companions. With regard to these folks, their own talk disability may preclude all of them through communicating in a fashion that enables these phones take advantage of their own possible within training, work as well as entertainment.

Talk disability is usually related to serious bodily afflictions due to intensifying nerve problems for example engine neuron illness, congenital problems for example cerebral palsy, or even obtained nerve problems due to heart stroke or even distressing mind damage. Present technical resources with regard to conversation, voice-output conversation helps (VOCAs), usually depend on the change or even computer keyboard with regard to enter. As a result, they may be hard to make use of as well as exhausting for a lot of customers, as well as they don't easily help organic conversation because they tend to be relatively sluggish as well as interrupt attention get in touch with [4]. O'Keefe ET al. [5] statement which customers require a gadget that is actually simple to run within an array of jobs as well as conditions. Lots of people along with VOCAs frequently would rather talk instead of make use of the help, even though their own talk is basically unintelligible, because it's a much more organic type of conversation [6]. Additionally, Todman et al. [7] discovered which audience ranked customers of the conversation helps because much more socially qualified when they experienced a far quicker price associated with shipping. It's therefore appealing that the brand new conversation help keep, so far as feasible, the actual pace as well as, preferably, the actual naturalness associated with voiced communication.

In spite of it's obvious appeal being an entry technique, the actual possible problems associated with realizing reduced talk possess designed the chance associated with voiced use of technologies continues to be unfulfilled. In a commercial sense obtainable automated talk acknowledgement (ASR) techniques can function nicely for a lot of along with moderate as well as reasonable dysarthria [8] as well as [9], however these types of research display that there's a good inverse romantic relationship between your level of impairment and also the precision associated with talk acknowledgement. For those who have serious talk disability, industrial talk acknowledgement systems aren't the practical entry answer. Furthermore, the actual small-scale lab tests documented within [8], [9] don't signify the number associated with environment problems which could be encountered unrealistic utilization, that may break down acknowledgement precision.

Therefore, whilst ASR may be utilized for several years like a approach to use of technologies through many people along with afflictions however unimpaired talk, this obtained small interest like a possible enter funnel with regard to VOCAs. Prior prototypes associated with voice-input voice-output conversation helps happen to be documented, however haven't already been examined thoroughly along with customers or even arrived at the actual phase to become obtainable because industrial items [10]. The different strategy may be suggested through Wise burn as well as Higginbotham that investigated the actual possibility of utilizing talk acknowledgement inside a VOCA to identify the actual talk of the discussion companion. This method had been after that accustomed to existing advised utterances towards the talk reduced person depending on exactly what their own conversation companion experienced stated.

ISBN No.978-1-4799-3834-6/14/$31.00©2014 IEEE

This particular document explains the actual improvement of the VOICE INPUT VOICE OUTPUT COMMUNICATION ASSISTS that is meant to identify as well as translate a person's disordered talk as well as provide the necessary information within obvious synthesized talk.

II. System Description

The actual improvement utilized the user-centered style as well as development paradigm. A preliminary comprehensive person needs research regarded as the actual sights associated with each possible VOICE INPUT VOICE OUTPUT COMMUNICATION ASSISTS customers as well as associated with talk as well as the meaning full vocabulary therapists/pathologists that supply voice-output conversation helps. An array of person requirements had been elicited and also the actual speak of VOICE INPUT VOICE-OUTPUT COMMUNICATION ASSISTS had been put in place to satisfy these types of needs exactly where achievable. The actual improvement procedure had been iterative and also the execution had been progressively processed through screening advancements along with several 4 possible VOICE INPUT VOICE OUTPUT COMMUNICATION ASSISTS customers. These types of 4 customers had been individuals with reasonable or even serious dysarthria, along with one person getting extra spoken dyspraxia. The voice entered in the system that will recognize each every word through the speech recognizer to that module. Also recognizing is work throughout the system. Where the user want to speak and translate the message to end user.

Fig. 1 exhibits the schematic from the program and it is main components. The consumer talk's right into a mike and also the talk is actually prepared as well as identified by the talk recognizer. The actual recognized phrases tend to be handed to some information creating component. Dependent about this enter, the actual information creating component may revise the actual display, possibly provide sound suggestions towards the person, as well as determine the number associated with feasible long term advices. This method proceeds within an iterative style since the person develops their own information. Once the information is actually total it's handed towards the talk synthesizer, generating intelligible voiced result using a loudspeaker. The machine elements tend to be referred to beneath.

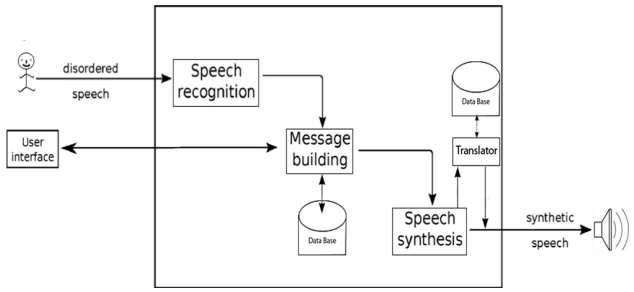

Fig. 1. Schematic diagram of the voice-input voice-output communication aissists

A. Speech Recognition

Within existing techniques, automated talk acknowledgement (ASR) is dependent on record versions (usually HMMs) associated with talk models. These types of versions tend to be educated on the big corpus (perhaps countless hours) associated with information documented through numerous loudspeakers. For any big vocabulary program, the actual talk models are going to be from the amount of individual talk seems cell phones. The actual ensuing speaker-independent recognizer could be modified to have a person loudspeaker, provided a tiny bit of enrolment talk information through which loudspeaker. Nevertheless, this particular ASR method is actually unacceptable with regard to loudspeakers along with serious talk problems simply because the quantity of materials available with regard to instruction is actually seriously restricted (as talking frequently demands excellent effort), the actual materials is actually extremely adjustable, frequently includes a limited phonetic repertoire, and it is as well not the same as the actual "normal" talk utilized in instruction speaker-independent versions for a lot of traditional variation processes to help. Rather, we now have launched a brand new strategy with regard to creating little vocabulary, speaker-dependent individual recognizers along with decreased levels of instruction information. By using this strategy, that all of us outline beneath, precise acknowledgement associated with seriously dysarthric talk may be proved to be simple for fairly little vocabularies.

Preliminary recordings had been gathered in the person. Based on their own choice they were gathered utilizing whether headset mike (Sony-Erikson Akono HBH-300 headset connected by way of Bluetooth), or perhaps a desktop computer mike (Acoustic Miracle Tone of voice Tracker variety microphone), attached to the laptop (Dell Inspiron 1100). Indicators had been experienced from 8 kHz, the most sample rate of recurrence about the Wireless Bluetooth sound funnel.

The actual recordings contain remote shows associated with each one of the phrases which are necessary for the actual recognizer's enter vocabulary. These types of good examples are utilized to coach the first entire term versions. With this research all of us utilized HMMs along with 11 say, having a straight-through agreement. The actual traditional acoustic vectors had been 12 Mel-frequency spectral coefficients (MFCCs) based on the 26-channel filter bank having a twenty five Microsoft evaluation eye-port as well as 10 Microsoft frame-rates. Power normalization as well as spectral imply normalization had been additionally put on the actual enter functions. This can be a traditional ASR front-end. The actual versions had been educated while using HMM toolkit using the Baum-Welch formula.

This method is easy for any standard loudspeaker, however it is actually much more challenging for that meant customers of the VOICE INPUT VOICE OUTPUT COMMUNICATION ASSISTS because of their talk disability. What this means is there's a shortage associated with instruction information and also the outcomes of this tend to be amplified through the variability within the shows

ISBN No.978-1-4799-3834-6/14/$31.00©2014 IEEE

associated with loudspeakers along with dysarthria. Nevertheless, the actual strategy referred to at length within is by using the first recordings in order to estimation versions that may be integrated right into “user-training" software. This particular software encourages the consumer frequently in order to talk each one of the phrases within the preliminary recognition language. Every utterance is actually documented, however crucially the consumer is actually provided suggestions upon "closeness associated with fit" of every make an effort to their very own acknowledgement design. This is determined from the log likelihood from the design producing the term through the probably route (computed through the Viterbi algorithm). The consumer can also be led with this procedure through having the ability to pay attention to their own "best try to date, inch so they might make an effort to duplicate this. Right here, "best" implies that instance that the present term design will be probably to create. Prior research show which each hearing their own prior greatest try, as well as repetitive practice might have an excellent impact within backing the prospective utterance, which has got the extra advantage of supplying extra instruction good examples with regard to re-training acknowledgement versions.

We now have formerly discovered which acknowledgement accuracies over 80% with regard to remote phrases, as well as over 70% with regard to instructions (short guitar strings associated with words) tend to be regularly achievable with regard to little vocabularies associated with seriously dysarthric talk. Although house manage duties can be executed having a fairly few control advices (and little enter language associated with close to 10-15 words), helping talk conversation demands much more versatility within its result and it is consequently prone to need a bigger enter vocabulary. With regard to speaker-dependent acknowledgement it's recognized which term acknowledgement precision drops along with growing language dimension, which decrease will probably be amplified whenever talk enter is actually extremely adjustable, because may be the situation along with dysarthric talk. Therefore, a significant problem with this function is actually every single child accommodate bigger enter vocabularies although keeping suitable amounts of term precision.

B. Message Building

The actual information creating component constructs communications that the person wants in order to connect, in the acknowledged enter phrases. Utilizing enter talk they are driving result talk from the VIVOCA provides a brand new problem that is not tackled in a level within prior investigation. The easiest, as well as in lots of ways the perfect, type of information creating, considering the fact that we're realizing term models, is always to identify every term separately as well as talk away exactly the same term inside a better (synthesized) tone of voice. Nevertheless, because the precision from the acknowledgement associated with seriously dysarthric talk reduces quickly since the enter language dimension raises, this isn't presently feasible as well as we're used restricted to locate techniques that produce significant messages however that need fairly little enter vocabularies.

We have to constrict the actual "perplexity" from the acknowledgement job, that's the quantity of phrases that the recognizer should choose from in a provided stage along the way. Carrying this out also offers the benefit of which makes it simpler for that person in order to remember exactly what the actual recognizer need from any kind of stage.

Among the crucial factors may be the pace where individuals can connect. All of us determine conversation price because the amount of phrases for each device period that are produced properly based on the motives from the person. With this description, the actual modification associated with mistakes should be taken into consideration, as well as this can be a main thing to consider whenever coping with talk acknowledgement, because mistake prices tend to be higher when compared with other enter techniques.

Modeling conversation price with regard to various information creating techniques demonstrated which, within problems associated with higher recognition precision, techniques using the bigger enter vocabularies provide higher conversation prices, consistent with anticipation. However, because of the period price associated with fixing mistakes, conversation price drops away quickly along with lowering acknowledgement price. Through mixing the actual types of conversation price along with home elevators acknowledgement precision with regard to a variety of enter language dimensions, we could estimation the actual conversation price from the information creating means of various amounts of intensity associated with dysarthria. For people along with moderate as well as reasonable dysarthria, the actual good romantic relationship in between enter language as well as conversation price is actually maintained. Nevertheless, for all those individuals with worse dysarthria, this isn't the situation. Due to the actual decrease associated with acknowledgement price along with growing enter language, the actual good romantic relationship in between enter language as well as conversation price no more retains. For those who have serious dysarthria, information creating methods needing an inferior enter language tend to be, counter-intuitively, better.

Included in the user-centered style as well as improvement procedure, style conferences had been kept between your investigation group as well as potential customers where various message-building techniques had been regarded as, along with understanding of the actual modeled conversation prices. Customers prioritized techniques that were known to possess higher conversation price. A few customers, nevertheless, additionally regarded as a sizable result language to be essential no matter its impact on conversation price. All of us consequently chose to put into action the crossbreed interpretation technique because a mix of expression creating as well as punctuation, the following.

Expression creating can be used to create commonly used key phrases needing quick era, for example responding to the telephone, speaking verbosity or even interacting instant needs/problems. For instance, typing the actual series associated with phrases "want" "drink" "water" might generate the phrase "Can I have a drink associated with drinking water make sure you. Inch By using this strategy inside an organized

ISBN No.978-1-4799-3834-6/14/$31.00©2014 IEEE

method significantly decreases the actual acknowledgement perplexity. Punctuation can be utilized for that rest associated with less-frequently utilized phrases permitting limitless result language exactly where higher accuracy as well as conversational variety are needed, although from the price of higher perplexity and far reduce conversation price.

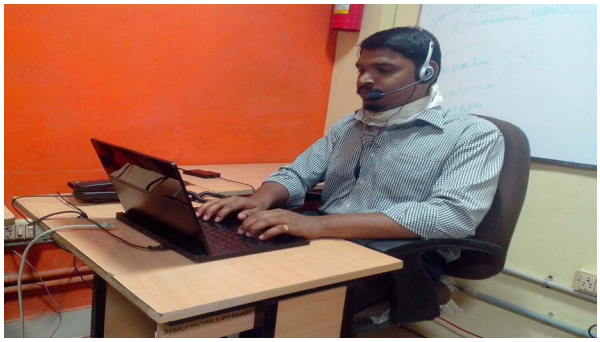

Fig. 2. An associate from the task group showing the actual prototype VOICE-INPUT VOICE-OUTPUT COMMUNICATION ASSISTS gadget. The consumer is actually putting on the headset mike, and also the VOICE-INPUT VOICE-OUTPUT COMMUNICATION ASSISTS software program is actually operating about the PERSONAL DIGITAL ASSISTANT installed on to their wheelchair.

The actual aspects of the actual information creating technique, and also enter as well as result vocabularies had been separately customized towards the requirements as well as wants of every participator. For example, these people could select settings that may be accustomed to chart phrases on to key phrases or even permit the punctuation associated with phrases or even a mix of each. It's envisaged which, when the VOICE-INPUT VOICE-OUTPUT COMMUNICATION ASSISTS gets much more accessible, this particular individualization is going to be completed through the owner's talk as well as vocabulary pathologist or even comparable medical expert.

C. Speech Synthesis

Among the person needs for that program result had been which it ought to be feasible to possess each prerecorded as well as artificial result, which the actual artificial result ought to be because organic sound as you possibly can.

To fulfill these types of needs, the machine software program had been designed to utilize each prerecorded result (in the shape associated with waveform files) and also to user interface having a talk synthesizer. Just like the procedure associated with talk acknowledgement, talk functionality is really a computationally challenging procedure. For that improvement of the prototype all of us employed a little impact talk synthesizer designed with regard to cellular pc systems known as Filet, the industry version from the bigger as well as well-liked functionality program referred to as Event [26]. The specifically put together edition from the Filet software program had been ready for those Home windows Cellular with regard to Wallet COMPUTER operating-system.

D. Translation

Voice is the synthesis of audible speech from computer readable text. The voice synthesis technology is based on taking any plain text, analyzing it by means of the speech synthesis engine, processing the information and finally converting it to the voice stream form, which can be stored or saved in various audio file formats. The advent of this technology was a major breakthrough in the language-learning field, bringing sound to written texts, helping learners connect the two vital parts of the language-learning process - it is just as important to see the word as to hear the way it is pronounced.

Today, there are quite a few speech synthesis software products specific to language-learning, and they are more reliable and affordable than ever before. Encompassing a great number of languages, the language study applications definitely have a great potential for helping you master languages much faster than you would have otherwise, had you not the audio component.

E. Hardware and Software Implementation

To be able to fulfill users' needs, the actual equipment where VOICE INPUT VOICE OUTPUT COMMUNICATION ASSISTS had been put in place must be little as well as gentle and also have an appropriate visible user interface. Once the VOICE-INPUT VOICE-OUPUT COMMUNICATION ASSISTS development started, within 2005, the best option equipment had been evaluated to become an individual electronic helper (PDA). The actual versions utilized in this particular research had been the actual HEWLETT PACKARD iPAQ HX2700 operating Home windows Cellular 5.0 with regard to Wallet COMPUTER. The actual PERSONAL DIGITAL ASSISTANT requires tone of voice enter in the person using a mike, which could possibly end up being head-worn (Bluetooth or even wired) or even lapel-type, or even the interior mike from the PERSONAL DIGITAL ASSISTANT. The actual PDA's inner loudspeaker had been discovered to create talk from as well reduced the quantity with regard to useful use within any kind of however peaceful background problems. Consequently, another amplifier as well as loudspeaker had been employed for the actual voiced result. Fig. two exhibits the actual PERSONAL DIGITAL ASSISTANT operating the actual VOICE-INPUT VOICE-OUTPUT COMMUNICATION ASSISTS software along with enter using a Wireless Bluetooth mike

The actual main digesting models within PDAs don't have assistance with regard to quick statistical calculation, and also have absolutely no devoted equipment with regard to floating-point information. It's nevertheless feasible to do floating-point procedures on the PERSONAL DIGITAL ASSISTANT; nevertheless, these people require software program emulation from the devoted equipment available on stronger processors. This particular emulation is a lot reduced than the usual devoted device as well as testing demonstrated this decrease in pace launched a substantial cost to do business with regard to talk recognition.

An answer is by using an alternative solution to signify actual numbers - namely the fixed-point rendering. The fixed-point rendering is really a way of utilizing binary integers in

ISBN No.978-1-4799-3834-6/14/$31.00©2014 IEEE

order to signify fractional amounts; nevertheless, for just about any fixed-point rendering it's important to utilize a devoted collection associated with features to do fundamental numerical procedures. Consequently, the initial step which was needed, prior to the aspects of the machine might be put in place, had been the actual improvement as well as screening of the collection associated with numerical procedures for the selected set stage representation.

All of us created as well as examined the collection with regard to fixed-point math with a Queen structure Q18.14. The actual collection contains the fundamental procedures upon set stage amounts (add, take away, and so on.), in addition to more complicated procedures for example logarithm, rapid and also the trigonometric features, which are needed for that transmission digesting as well as talk acknowledgement areas of the machine.

An additional result from the restrictions from the CPUs available upon PDAs designed which, for that prototype program, the program to coach acknowledgement versions as well as configure the actual help wasn't located on the PERSONAL DIGITAL ASSISTANT, instead on the traditional COMPUTER. This particular choice had been taken to expedite the time that would be required to train a set associated with versions on the gadget along with this kind of restricted digesting energy.

User Interface—User Training Application The very first interface how the person encounters may be the user-training application. Fig. 3 exhibits a number of instance display shows in the PDA-based person instruction software. The actual user interface at first encourages the consumer in order to talk the term. Once the person talks the term, the acknowledgement rating showing the actual "closeness associated with fit" of every make an effort to their very own acknowledgement design is actually denoted through the quantity of the actual dark group that's full of color. Within Fig. 3 solar panel W, a higher (89%) rating is actually proven, and also the group is almost completely stuffed; while solar panel D exhibits a minimal (37%) rating.

User Interface—VOICE-INPUT VOICE-OUTPUT COMMUNICATION ASSISTS Application: To be able to facilitate attention get in touch with in between conversation companions, we'd initially envisaged which customers could make use of the VOICE-INPUT VOICE-OUTPUT COMMUNICATION ASSISTS without having talking about the display, getting important audible encourages by way of a good earpiece. The person needs investigation, nevertheless, pointed out which customers regarded as the display because essential. We now have, consequently, put in place each screen-based as well as sound interface. Fig. four exhibits the actual screen-based user interface, where the obtainable language is actually detailed within the whitened room. The consumer selects the right enter term and also the expression, since it accumulates, is actually proven within the best solar panel. Obviously, the actual sound user interface may become unwieldy with regard to big vocabularies. To be able to start the actual acknowledgement associated with a number of phrases (the enter phrase) resulting in the actual era of the result expression, the consumer is needed to push the change to point how the recognizer must start in order to "listen. Inch Since the customers are usually individuals with serious bodily afflictions, the actual change is actually selected as well as setup for every person.

After that the received voice has been translated in to any other language with accurate.

III. COMPARISON

The tone of voice result conversation help controlled through automated talk acknowledgement may be effectively created as well as examined. The actual improvement of the gadget adopted the user-centered iterative procedure, where several customers examined every phase from the improvement which resulted in adjustments as well as enhancements towards the gadget. The actual ultimate goal would be to create a VIVOCA device which may be commercialized and also the style functions which surfaced out of this procedure ought to help to make the ultimate gadget appropriate to some broader number of clients.

This particular research offers, nevertheless, once again outlined a significant distinction within acknowledgement precision within managed problems, when compared to precision achieved below practical utilization conditions.

Because, with regard to factors associated with comfort and ease as well as comfort, the majority of the customers experienced not able to utilize a close-talking mike with regard to daily utilization, rather selecting to make use of the actual PDA's inner mike, the actual mismatch between your microphones employed for instruction as well as screening had been a substantial reason for degraded overall performance.

Prior use speech-input house manage techniques experienced comparable useful problems as well as shown comparable performance destruction. While with regard to house manage programs a few customers discovered the amount of overall performance suitable, with regard to manage of the VOCA, suggestions through customers offers verified which this kind of overall performance isn't suitable which greater precision from bigger language dimensions is important.

All of us determine which a few basic useful problems associated with utilizing talk acknowledgement along with handicapped customers should be tackled prior to the VIVOCA may become the practical device.

The very first of those is to create a VIVOCA depending on the system that facilitates a much better high quality inner microphone that is the majority of users' favored choice.

In this research we implemented the language translation this is the main major of this project.

IV. CONCLUSION

This particular document offers referred to the actual improvement associated with transportable, tone of voice result conversation help controlled through automated talk acknowledgement. These devices could be set up make it possible for the consumer to produce possibly easy or even

ISBN No.978-1-4799-3834-6/14/$31.00©2014 IEEE

complicated communications utilizing a mix of a comparatively little group of enter "words. Inch Assessment along with several possible customers demonstrated that they'll utilize the gadget to create intelligible talk result. The actual assessment additionally, nevertheless, outlined a number of problems that restrict the actual performance as well as user friendliness from the gadget, credit reporting which additional function is needed prior to this gets a suitable device for those who have reasonable in order to serious dysarthria. Conquering these types of restrictions would be the concentrate in our long term investigation.

ACKNOWLEDGMENT

The actual writers desire to say thanks to all of the individuals that threw in the towel their own time for you to be a part of this particular research.

REFERENCES

[1] D. Beukelman and P. Mirenda, Augmentative and Alternative Communication, 3rd ed. Baltimore, MD: Paul H. Brookes, 2005.

[2] P. Enderby and L. Emerson, Does Speech and Language Therapy Work?. London, U.K.: Singular, 1995.

[3] C. L. Kleinke, "Gaze and eye contact: A research review," Psychol. Bull., vol. 100, no. 1, pp. 78–100, 1986.

[4] B. O'Keefe, N. Kozak, and R. Schuller, "Research priorities in augmentative and alternative communication as identified by people whouse AAC and their facilitators," Augmentative Alternative Commun., vol. 23, no. 1, pp. 89–96, 2007.

[5] J. Murphy, "I prefer contact this close: Perceptions of AAC by people with motor neurone disease and their communication partners," Augmentative Alternative Commun., vol. 20, pp. 259–271, 2004.

[6] J. Todman, N. Alm, J. Higginbotham, and P. File, "Whole utterance approaches in AAC," Augmentative Alternative Commun., vol. 24, no.3, pp. 235–254, 2008.

[7] N. Thomas-Stonell, A. L. Kotler, H. A. Leeper, and P. C. Doyle, "Computerized speech recognition: Influence of intelligibility and percep-tual consistency on recognition accuracy," Augmentative Alternative Commun., vol. 14, no. 1, pp. 51–56, 1998.

[8] R. N. Bloor, K. Barrett, and C. Geldard, "The clinical application of microcomputers in the treatment of patients with severe speech dysfunction," IEE Colloquium High-Tech Help Handicapped, pp. 9/1–9/2, 1990.

[9] U. Sandler and Y. Sonnenblick, "A system for recognition and translation of the speech of handicapped individuals," in 9th Mediterranean Electrotech. Conf. (MELECON'98), 1998, pp. 16–19.

[10] B. Wisenburn and D. J. Higginbotham, "An AAC application using speaking partner speech recognition to automatically produce contextually relevant utterances: Objective results," Augmentative Alternative Commun., vol. 24, no. 2, pp. 100–109, 2008.

[11] B. Wisenburn and D. J. Higginbotham, "Participant evaluations of rate and communication efficacy of an AAC application using natural language processing," Augmentative Alternative Commun., vol. 25, no. 2, pp. 78–89, 2009.

[12] M. S. Hawley et al., "A speech-controlled environmental control system for people with severe dysarthria," Med. Eng. Phys., vol. 29, no. 5, pp. 586–593, 2007.

[13]]H. V. Sharma and M. Hasegawa-Johnson, "State-transition interpolation and MAP adaptation for HMM-based dysarthric speech recognition," in NAACL HLT Workshop Speech Language Process. Assistive Technol., 2010, pp. 72–79.

[14] R. Palmer, P. Enderby, and M. S. Hawley, "A voice input voice output communication aid: What do users and therapists require?," J. Assistive Technol., vol. 4, no. 2, pp. 4–14, 2010.

[15] S. Young et al., Cambridge University Engineering Department The HTK book, 2006.

[16] P. D. Green, J. Carmichael, A. Hatzis, P. Enderby, M. S. Hawley, and M. Parker, "Automatic speech recognition with sparse training data for dysarthric speakers," in Eur. Conf. Speech Commun. Technol. (Eurospeech), 2003, pp. 1189–1192.

[17] L. R. Rabiner and B. H. Juang, "An introduction to hidden Markov models," IEEE ASSP Mag., Jun. 1986.

[18] R. Palmer, P. Enderby, and S. P. Cunningham, "The effect of three practice conditions on the consistency of chronic dysarthric speech," J. Med. Speech-Language Pathol., vol. 12, no. 4, pp. 183–188, 2004.

[19] M. Parker, S. P. Cunningham, P. Enderby, M. S. Hawley, and P. D. Green, "Automatic speech recognition and training for severely dysarthric users of assistive technology: The STARDUST project," Clin. Linguistics Phonetics, vol. 20, no. 2–3, pp. 149–156, 2006.

[20] J. N. Holmes and W. J. Holmes, Speech Recognition and Synthesis, 2nd ed. London, U.K.: Taylor Francis, 2001.

[21] S. L. Glennon and D. C. DeCoste, Handbook of Alternative and Augmentative Communication. San Diego, CA: Singular, 1997.

[22] J. Todman, "Rate and quality of conversations using a text-storage AAC system: Single-case training study," Augmentative Alternative Commun., vol. 16, no. 3, pp. 164–179, 2000.

[23] M. S. Hawley, S. P. Cunningham, F. Cardinaux, A. Coy, S. Seghal, and P. Enderby, "Challenges in developing a voice input voice output communication aid for people with severe dysarthria," in Proc. AAATE—Challenges Assistive Technol., 2007, pp. 363–367.

[24] A. Black and K. Lenzo, "Flite: A small fast run-time synthesis engine," in 4th ISCA Speech Synthesis Workshop, 2001, pp. 157–162.

[25] A. W. Black, P. Taylor, and R. Caley, The Festival Speech Synthesis System. Edinburgh, Univ. Edinburgh, 1999.

[26] P. Enderby and R. Palmer, Frenchay Dysarthria Assessment, 2nd ed. Austin, TX: Pro-ed, 2008.

[27] Mark S. Hawley, Stuart P. A Voice-Input Voice-Output Communication Aid for People with Severe Speech Impairment, vol. 21, no.1,,2013

ISBN No.978-1-4799-3834-6/14/$31.00©2014 IEEE