Review on Mobile Application for Children Suffering From Autism

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Abstract— Mobile devices have gained tremendous attention within the special needs community in recent years. These devices serve as a learning platform and communication interface for people with weak motor and communication skills. Flexible multimedia content, storage, portability, mobility and affordability are some of the features of this technology. Advanced capabilities of mobile technology are opening new opportunities for further research in the area of computer-based intervention for children with Autism Spectrum Disorder (ASD) spearheading the Orange Technology growth. Children with ASD exhibit impairments in social communication and learning capability. Touch screen interface is appealing and easy to use due to the presence of strong visual spatial skills as compared to traditional paper or board based systems for these children. Android is by far the most widely used operating system for mobile devices today and has various inbuilt features for assistive technology. This review paper presents three key aspects for an assistive learning tool. The foremost being database creation and management in Android devices with SQLite as the proposed system architecture. Following which the need for natural language processing and text to speech conversion is highlighted. A comparison is drawn between current technologies and finally a review is presented of two existing applications: iCan and LINKX Project. The results show the positive impact these applications are generating in assisting children with autism towards a normal life. There is scope for in-depth research studies on the effect of mobile technology for children with ASD potentially helping them improve their standard of life.

Keywords— Autism, Speech Synthesis, Language Learning, Mobile Application

I. INTRODUCTION

   Autism spectrum disorder (ASD) is a range of complex neurodevelopment disorders, with the hallmark feature identifiable by impaired social interaction. [1] Contrary to the general belief; autism is not a disability but a spectrum of disorders. According to statistics by the Centres for Disease Control and Prevention (CDC), one in every 88 children today is born with autism spectrum disorder (ASD) against a ratio of one in 110. Autistic children adapt well to visual exposure and have an eye for detail. Their manner of communicating, conveying emotions and processing thoughts distinctly differs from what a normal child's manner. Through this paper, we will be reviewing the various technologies capable of aiding children with autism in learning new words and day-to-day communication. In the latter half of the paper we will discuss two existing mobile applications meant for educating and guiding children suffering from non-verbal autism.

II. BRIEF DESCRIPTION

A. Creating a Database

   According to author, in current system, data will be stored from android phone into SQLite database. If we want to save data in common place i.e. Remote Server, until now there was no easy way to implement this. The need for storing data in Remote Server exists because even if the mobile is lost or stolen, you can get back your data stored in the phone. The idea of storing information in Remote Server is done using Web Services which can save data in remote databases like SQL server. There are several drawbacks of the existing system which will be covered by applying certain algorithm or structure which is explained in next section which includes: No full access to data i.e. database not accessible from outside the application, flexibility issues, and problems with security.

B. Proposed Database System

   Drawbacks mentioned above can be solved using SQL database server. Our proposed system is completely based on Service Oriented Architecture (SOA) where clients can be blackberry, android, IOS etc. Services are self-contained and will be communicating through xml language [2]. SOA is style for building application which performs certain functionality when combined together. Once we have web service in remote server with centralized database then we can use the same service for different clients like Android, Blackberry, windows phone etc. Therefore all kind of clients will have a common web service to save and retrieve data. They also have the option take backups.
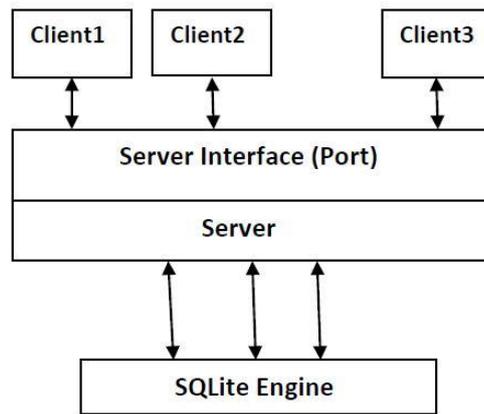
Fig 1: Service Oriented Architecture

C. Speech Synthesis

Text to speech is used to transform lingual information in the form of data or text into the form of speech. It has various applications in the real time environment. In the paper presented authors have attempted to generate natural language by synthesis in MATLAB. The authors suggest a method of recording word pronunciations with the help of a microphone and disintegrating them into phonetics after sampling and application of MATLAB functions and finally concatenate them to produce desired words.

In the method presented word pronunciations are recorded via a microphone and its spectrogram is analysed to identify phenomes (Out of the 44 present in the English language) [3]. The transformation of phonetic set to an acoustic waveform can be achieved by three distinct methods- articulatory synthesis, synthesis by rule and synthesis by concatenation. [4] The most widely used technique out of the three- synthesis by concatenation is applied by the author to obtain high quality speech. The approach requires a user to record audio for short phenomes which are then processed and stored in a database. For a new production the system follows established rules and concatenate required phonetic notation.
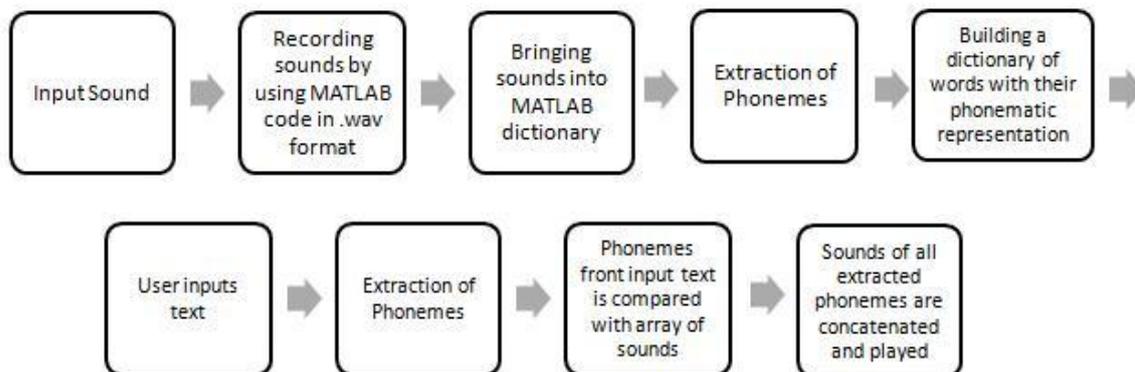

Fig 2: Flowchart for simple matrix operations module [5]

D. Applications for children with Autism
iCan

Various techniques have been implemented as an attempt to develop communication skills and social interactions of a child suffering from autism. The most primitive, and by far largely accepted, being Paper-made Picture Exchange Communication System. The PECS is essentially a stack of picture cards which a child can use to successfully convey feelings or needs by constructing meaningful sentences.

Keeping aside the critical importance Paper-based PECS hold there are several drawbacks associated with the method. To overcome them a group of researchers at National Taiwan University of Science and Technology developed iCan, a tablet based application that uses digital PECS system with picture cards that can be dragged and dropped overcoming the difficulties of creating, portability and management of paper based PECS system. [6]

The process followed a research-through-design paradigm [7] and comprised of three levels with respect to User Experience- Research, Design and Testing. The application aids in assistive learning enabling autistic children communicate with their caregivers coherently. Information obtained by means of ethnographic interviews was used to create a prototype that included a picture card, which when pressed would pronounce the word on the card, and sentence construction by long pressing selected cards. Cards can be regularly added by using the device's camera and microphone to record the picture and associated sound. The prototype was then presented to a group of 11 autistic children, between 5 to 16 years exhibiting verbal communication from none too low, and their caregivers. The repeated testing and designing cycles experimented with different platforms-presentations, keynote and android. The final application was deployed on an android platform with considerable changes as a result of feedback from the children, their caregivers

and professional educators. It categorized picture cards with respect to a label, color and small picture. The results showed significant reducing of the burden of producing picture and cards and the teaching burden, which have been published [8] The authors further draw a comparison between Traditional PECS (TPECS) and digital PECS and it is found that in terms of cognition, perception and behavior- iCan yielded better results proving it to be a useful Orange Technology.

LINKX Project

LINKX Project was undertaken by a multidisciplinary team to create a language learning toy for autistic children. The paper lists down design guidelines that should be implemented while designing prototypes to teach these kids while understanding their experiential world. The authors suggest a close relationship with the children for a deep empathetic understanding and guidelines on an operational level to materialize innovations and ideas into physical products. [9] The language toy works on the understanding that autistic children comprehend things differently as compared to normal children and need to 'puzzle it together' [10]

The interactive toy initiated by attempting to teach these children 100 everyday words by means of a toy piece and speech-o-gram. The caregivers record word pronunciation in the speech-o-gram and attach it to the respective object. The child can now play with the block and each time he/she connects it to the right object it lights up and says the word aloud. The guidelines illustrated in the paper for a wholesome learning experience are- Giving the kids a Feeling of Being in Control, Providing a Structured Situation, Letting Them Create a Structure Themselves, Making Use of Their Special Interests, Facilitating Their Excellent Memory, Rewarding Them with Sensory Experiences, Facilitating Their Eye for Detail and Letting Them Use Their Whole Body. [9] These guidelines were exercised when 3 families agreed to volunteer for the project and used the prototype with three young boys suffering from autism of varied levels. The aim of the paper essentially was to lay down preliminary rules for designing UI/UX for applications for autistic children.

III. INFERENCE

TABLE I

Criteria	Existing System	Proposed System
Data Storage	Stored at SQLite Database	Stored at a centralized database in remote server
Accessibility	Third party applications cannot gain access into the database	Data Access relatively seamless
Memory	Device memory used to store data hence limitations observed	Transactional Database Engine requires minimum storage on device
Usability	Single Device	Multiple Clients

TABLE III

Criteria	iCan	LINKX Project
Type	Android Application Running on Tablet Devices	Physical Language Learning Toy
Target Group	Autistic children and their caregivers	Autistic Children
Focus on Skills	Communication Skills	Learning new words and associating them

		with physical objects
Technique Used	Natural Language Processing via PECS	Speech-o-grams and pictures
Advantage over Paper based PECS	Hassle-free process to create, manage and use PECS digitally	Prompts via sensory experiences- light and audio
Advantages for children's growth	Appeals to children and helps develop their hand-eye coordination	Helps the children use their entire body and encourage their knack for detail

IV.   CONCLUSION

This paper describes various aspects of a communication assistive mobile technology that can be developed for children with autism. With several upcoming applications, this review highlighted the importance of android as an interactive mobile operating system. Database as well as natural language processing techniques can be integrated well with the OS. Applications iCan and the LINKX project focus on an ethnographic and empathetic approach with autistic children in order to develop application to alleviate their quality of life.

V.   FUTURE WORK

The scope of research is vast both in terms of psychology and technology to help those living with autism. One of the challenges is to formulate and more intuitive and natural-sounding speech synthesis algorithm to enable a patient suffering from Autism communicate and express with ease. Feasibility and performance evaluation of implementing both- error modeling as well as adaptation techniques to provide a robust algorithm could be undertaken as well.

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