

MOGAT: A Cloud-based Mobile Game System with Auditory Training for Children with Cochlear Implants

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ABSTRACT

Musical auditory habilitation is an essential process in adapting cochlear implant recipients to the musical hearing context provided by cochlear implants. However, due to the cost and time limitation, it is impossible for hearing healthcare professionals to provide intensive and extensive musical auditory habilitation for every cochlear implant recipient. In order to provide an efficient and cost-effective musical auditory training for children with cochlear implants, we designed and developed MOBILE Games with Auditory Training (MOGAT) on off-the-shelf mobile devices. MOGAT includes three intuitive and interesting mobile games for training pitch perception and production, and a cloud-based web service for music therapists to support and evaluate individual habilitation. We demonstrate MOGAT for enhancing musical habilitation for children with cochlear implants.

Categories and Subject Descriptors

H.5.2 [User Interfaces]: User-centered design; H.5.5 [Sound and Music Computing]: Signal analysis, synthesis, and processing; K.4.2 [Social Issues]: Assistive technologies for persons with disabilities

General Terms

Design, Experimentation, Human Factors.

Keywords

Music, mobile, game, auditory habilitation, cochlear implant, children.

1. INTRODUCTION

Cochlear implants (CI) are surgically implanted electronic devices using electronically simulated sound to restore hearing sense to the hearing impaired. Since CIs are designed mainly for speech communication, they are far from satisfactory for music perception, especially pitch perception. Musical auditory habilitation is usually set up as an adjuvant process to their routine habilitation, which is to enhance their adaption for the devices post cochlear implantation. However, considering the cost and time of hearing healthcare professionals, it is impossible to fulfill every CI recipient's needs for auditory habilitation. Furthermore, focusing



Figure 1: MOGAT Architecture

on speech habilitation, existing systems [2, 1] fail to provide enhanced musical habilitation for children with CIs.

In order to enhance musical habilitation for pre-lingually deafened children with CIs, we designed MOGAT [4] on off-the-shelf mobile devices. MOGAT aims to train the pitch perception and production for children with CIs in a fun, intuitive, and cost-effective way. MOGAT includes three structure music games: *Higher Lower*, *Vocal Matcher*, and *Ladder Singer*. All the data, including scores and recordings, are uploaded to our cloud service, which enables music educators and therapists to support children's habilitation remotely. Via a cloud-based web service, teachers are able to visualize individual student progress, listen to their singing recordings, add comments and ratings, and organize their activities. Figure 1 shows the architecture of MOGAT cloud computing service.

2. SYSTEM DESCRIPTION

MOGAT consists of 3 musical games built in a native iOS app and a cloud-based web service. The 3 musical games were designed to help users to practice their pitch discrimination and production skills. Audio and scores are recorded in the local devices and uploaded to our cloud computing service. The web service aims to enhance music therapists and educators' abilities in supporting and managing a large number of children's habilitation.

2.1 Mobile Games

We have developed 3 musical mobile games: *Higher Lower*, *Vocal Matcher*, and *Ladder Singer*.

Higher Lower: The goal is to train children's pitch in-

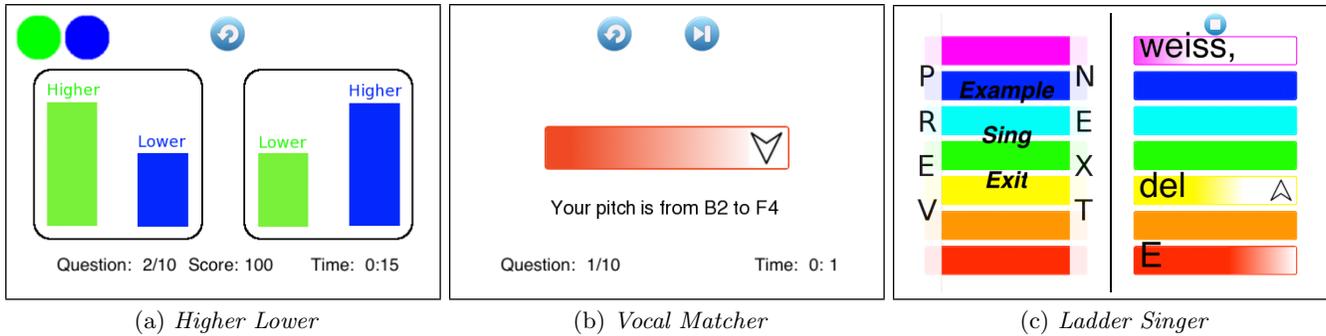


Figure 2: The game interfaces in MOGAT

terval perception skills (in Figure 2a). The game starts by playing two notes with one note being higher than the other. Children are required to indicate the answer by pressing one of the two buttons on the game interface. If the answer is correct, the game will show the encouragement by displaying the word “Correct” with a burst of fireworks; otherwise, the game will play the notes again for the children to correct their errors.

Vocal Matcher: The goal is to focus on children’s single-note intonation skills with appropriate voice control (in Figure 2b). First, the game plays back the single note; second, children are asked to sing that note and sustain it up to 1 second. The game provides automatic note checking for children to correct their pitch.

Ladder Singer: The goal is to practice singing a melody using a simple metaphor “color ladder” to represent each note (in Figure 2c). Each note within the song is displayed as one “stair” in the ladder and notes are sorted ascendingly from bottom to top on the screen. In order to make the game intuitive and simple to learn, we integrate the note duration, lyrics, and hints for correction into the note bar. Meanwhile, children can learn the song phrase by phrase.

To enable the app to interact with RESTful web services, MOGAT leverages RestKit [3], an Objective-C framework for iOS, to wrap it with RESTful APIs.

2.2 Cloud-based Web Service

Given all the game information stored in our database, music therapists and educators can use the designed web service to access and evaluate children’s progress. The PHP web service provides the following 4 major functionalities:

- A. Individual progress tracking:** Teachers can view a graphical visualization of a student’s scores over a daily, weekly, or monthly period. Furthermore, they can listen to students’ singing recorded in games to pinpoint students’ singing problems.
- B. Enabling reciprocal interaction:** Teachers can examine students’ singing, give overall rating, and post comments. Teachers can use the comment function to suggest improvement for children. The elements of social media interaction in the website grant more flexibility and accessibility to students and teachers for communicating with each other.
- C. Events planning:** Teachers can plan students’ habilitation in an event calendar by which they can decide time, location, game, and difficulty for a student to play according to his/her performance. The event in-

formation will be automatically sent to mobile devices, which will then set up a notification alarm.

- D. Leader board:** Students and teachers can check the score leader board within a day, a week, and a month, which can introduce a moderate amount of competition to increase motivation to practice.

3. DEMONSTRATION

We will demonstrate MOGAT used by a child with cochlear implant. The child uses *Ladder Singer* (as Figure 2c) to practice *Edelweiss*. The child first selects the phrase for practice by pressing “PREV” or “NEXT” button in the menu. By selecting *Example* item, the child listens to the example melody sung by the teacher. Then she presses the *Sing* item and starts to sing the phrase with real-time feedback in the game. When the phrase is finished, her recording file will be automatically uploaded to MOGAT server. A score to represent her singing proficiency will be assigned to her recording. The web service plots her daily/weekly/monthly progress based on these proficiency scores.

4. CONCLUSION

Taking advantage of user-centered design, we developed MOGAT specifically for the musical needs and cognitive abilities of children with CIs. It contains three mobile musical games to enhance users’ pitch-based habilitation, and a cloud-based web service to help their musical educators to support their habilitation remotely. The game scores and recordings are automatically uploaded, stored, and managed in the server which enables musical educators to visualize their progress, plan individualized habilitation, and provide constructive comments and ratings.

5. REFERENCES

- [1] Q.-J. Fu, J. Galvin, X. Wang, and G. Nogaki. Moderate auditory training can improve speech performance of adult cochlear implant patients. *Acoustical Society of America*, 6(3):106–111, 2005.
- [2] Q.-J. Fu and J. J. Galvin. Computer-assisted speech training for cochlear implant patients: Feasibility, outcomes, and future directions. *Seminar in Hearing*, 28:142–150, 2007.
- [3] RestKit. <http://www.restkit.org/>.
- [4] Y. Zhou, K. C. Sim, P. Tan, and Y. Wang. Mogat: Mobile games with auditory training for children with cochlear implants. In *ACM Multimedia '12*, 2012.