

# TouchTone – An Electronic Musical Instrument for Children with Hemiplegic Cerebral Palsy

Soumitra Bhat

MSc. Design for Engineering  
Delft University of Technology  
Landbergstraat 15, 2628CE, Delft, Netherlands  
soumitra.bhat@gmail.com

## ABSTRACT

Children with hemiplegic cerebral palsy often lack the physical skills to explore their environment independently, express feelings, communicate, and successfully participate in social activities. Creative music therapy aims to improve this situation by specifically addressing the emotional and social needs of these children. However, to be successful at these levels, the children need to have basic control over the musical instruments used in the therapy sessions. Traditional acoustic musical instruments demand high levels of sensori-motor coordination and precision making them difficult to control – thus affecting the efficacy of music therapy.

Executed during the Master Design for Interaction at the faculty of Industrial Design Engineering, TU Delft, TouchTone is an electronic musical instrument designed with a vision to develop musical ability, develop bimanual coordination and increase social participation of children with hemiplegia.

## Author Keywords

Electronic musical instrument, Hemiplegia, Cerebral palsy, Children, Tangible interaction.

## ACM Classification Keywords

J5 Performing arts (e.g., dance, music). K4.2 Assistive technologies for persons with disabilities.

## General Terms

Design, Human Factors

## INTRODUCTION

Hemiplegic cerebral palsy is the result of early brain damage. Children with hemiplegic cerebral palsy display poor temporal coordination by sequential performance of tasks typically involving asymmetrical bi-manual movement (e.g. opening a drawer and manipulating its contents). They have difficulty with motor planning and have low fine motor skills [3]. These problems may underlie some of the functional limitations these children experience in activities such as dressing, eating, and playing

sports [2]. Additionally, physical disabilities are known to affect broader aspects of lives of individuals, like the quality of life, and participation.

Among the various therapies prescribed to these children, music therapy is aimed at helping the children to experience challenge, alertness, and involvement. With practice, children can use music as a means to develop skills, communicate intention, and experience freedom beyond their physical restrictions. However, creative music making remains a difficult challenge for many children with hemiplegic cerebral palsy due to their inability to meet the high levels of sensori-motor coordination and precise control demanded by acoustic instruments. This inaccessibility of instruments forces children to take on passive roles in music therapy sessions – thus forfeiting the long-term, holistic benefits of creative music making.

## THE IDEA BEHIND TOUCHTONE

TouchTone is an electronic musical instrument which deliberately encourages physical engagement through tangible interface design to support musical creativity in children with hemiplegic cerebral palsy. It is designed to share the family of ‘Orff’ instruments, thereby placing it within a popular, proven musical education program for children [1]. TouchTone has been designed following a participatory design method involving close collaboration with music therapists and frequent iterative evaluation cycles with children.

## TOUCHTONE DESIGN AND FEATURES

TouchTone is designed such that the unaffected hand is used to activate pressure-sensitive pads that trigger pitches, while the affected hand is used to shift the octave of the instrument during performance (Figure 1). The pitches can be selected by hitting the black pads with fingers. The ‘Octave Jump’ button is a momentary switch that changes the octave when pressed. The pads are arranged in two rows of two groups of five. In the first row, each pad corresponds to a note on the pentatonic scale. Each pad in the second row has a pitch difference of a 3rd or 5th with a corresponding pad from row 1. There is an LED indicator associated with each pad.

TouchTone helps children develop musical ability by allowing them to practice rhythm, scales, modes, melody,

harmony. Children can use it as a companion for music education programs. It matches the development of children, and can help improve bimanual coordination by encouraging the use of the affected hand to actively participate in music performance.



**Figure 1: A child playing TouchTone.**

It allows playing as a lead as well as an accompanying instrument. It incorporates a learning module which can help therapists and children record exercises and set developmental goals. Children can visually follow an exercise on the instrument by following the LED indicator next to the specific pad.

### **EVALUATION AND RESULTS**

TouchTone has been developed in two cycles. The first prototype was tested with target children to evaluate the quality of interaction and extract reactions from music therapists and occupational therapists. The second prototype was used for testing the efficacy of the learning module and the use of TouchTone within individual and group music sessions.

The evaluation involved individual and group sessions. For the individual sessions, 6 children between 8 and 12 years of age used TouchTone for 15 minutes each. The tasks provided included 5 minutes of free exploration followed by 5 minutes of using the training module with a pre-recorded song. For the group session, TouchTone was used within an ensemble performance situation with 12 children and an accompanying music therapist.

The evaluation was successful. The instrument was found to offer a very high playability across variations in physical ability. Children could immediately understand the interaction and start playing the instrument. The pressure sensitive pads required very little force to be activated and thus contributed towards the high playability. The children displayed prolonged attention and concentration spans and actively engaged in exploring the instrument. The clear cause-effect relationship between action and sound aided this involvement and exploration. Children found using the Octave Jump function with the affected hand to be a

challenge, but they displayed significant progress in using both their hands in coordination.

Music therapists found the instances where a child was concentrating at his task of playing the instrument without needing any external motivation to be special. During group activities they demonstrated many ways for integrating TouchTone into music sessions. The tuning function within TouchTone allowed the therapist to set up an ensemble performance with other instruments. They especially liked the training module function and the possibility to have color LEDs light up to indicate notes.

### **CONCLUSIONS AND FUTURE WORK**

The instrument successfully achieved its design objectives by allowing children to make music easily and enabling them to develop specific physical abilities. The clear connection between the manipulation of tangible controls and the sound produced reinforced the cause and effect relationship between action and effect, leading to prolonged engagement, concentration and self-motivated exploration. The positive reception from therapists points towards successful adoption in music therapy practice.

Overall, the success of TouchTone underlines the potential efficacy of using tangible interfaces in designing expressive, artistic interventions for disabled children, and future work will focus on the design and systematic evaluation of TouchTone and other tangible interventions covering more activity domains.

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