Interactive Training Chopsticks to Improve Fine Motor Skills

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ACE '14, Nov 11-14 2014, Funchal, Portugal
ACM 978-1-4503-2945-3/14/11.
http://dx.doi.org/10.1145/2663806.2663816

Abstract
Handling chopsticks requires fine motor skills that are challenging to master. We present interactive training chopsticks that help children develop the skills of eating with chopsticks. We discuss the design and implementation of two games that use the chopsticks as a controller for an augmented mirror application.

Author Keywords
Chopsticks; Children; Augmented Mirror; Education; Gaming

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Most children learn eating with chopsticks by observing their parents. However, acquiring the skill and coordination can be tedious and demotivating.

In general, the fine motor skills and eye-hand coordination that are needed for eating with chopsticks are essential in many everyday activities: fastening shoelaces, tying a necktie, playing guitar and eating with utensils. All these activities have in common that we observe others from a different perspective than

when we look at our own hands and so makes the understanding of actions difficult.

Figure 1. A user using the interactive chopsticks to eat foods of various grasping difficulty.

In dancing, mirrors are commonly used to train physical movements and mirrors are thought to contribute to understanding actions by both visual recognition and motorically [1]. Therefore, we take a novel approach of teaching chopsticks skill by means of enhancing visual and motor familiarity [2] by providing an augmented mirror.

As shown in Figure 1, the interactive chopsticks design consist of a tangible "controller", a segmented plate and a tablet pc for visual feedback that mirrors the actions performed with the chopsticks. Two games are prototyped: Easy Clap for training fine-motor skills and Easy Pick for training eye-hand coordination. The games encourage positive behaviors and correct negative behaviors by giving positive and negative feedbacks in the game environment.

Related Work

A few systems with interactive cutlery are developed to raise the awareness of a healthy diet, improve eating habits or enhance the experience of eating.

The EducaTableware [4] and PlayFood Cutlery [7] present sonification of eating and drinking activities by playing prerecorded samples and theramin like interactive sounds by means of measuring resistance and conductivity. The Chewing Jockey [5] enhances the sound of chewing and so restores the sensation of food for people who cannot bite strongly and aims to help moderate eating speed. The Sensing Fork [3] analyses eating behavior and recognizes food type through color and conductivity sensing. The aim is to promote desirable eating patterns by providing an eating game. Narumi, et al. [6] take another approach to improve eating behavior by using augmented reality to change the apparent size of the food.

Although various related work aims to enhance eating behavior, none of these systems help develop the skill of eating with chopsticks or guide children through the required hours of repetitive practice. Therefore we build upon earlier work on motor skill development. Ballet dancers often use mirrors to acquire visual feedback and the use of video to playback and analyze motion is commonplace for sports enthusiasts and professionals. Youmove [1] is an augmented reality mirror for dancers to help provide an augmented reality mirror that helps master new postures. Similar, the interactive chopsticks presented in this creative showcase, provide feedback on child action and provide personalized motivation.

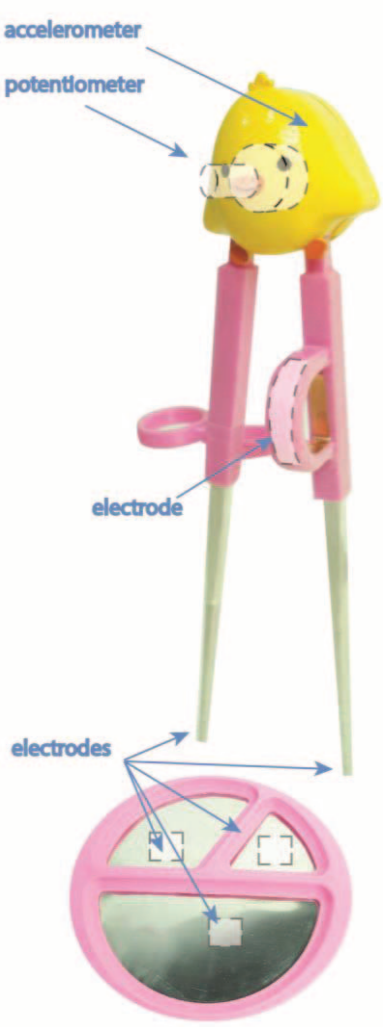

Figure 2. The chopsticks prototype consists of various sensors and electrodes to estimate users actions.

Chopsticks Design

Our chopsticks design for young children is based on the widely available training chopsticks. These chopsticks feature a hinge between the sticks to ease grasping action and they provide rings to fit the fingers to assure correct hand posture.

As shown in Figure 2, various sensors are embedded in the interactive chopsticks to capture user behavior. A potentiometer detects the angle between the two sticks and captures opening and closing actions. A triple-axis accelerometer estimates the orientation of the chopsticks by measuring tilt. Together these sensors allow mirroring the pose of the chopsticks on the tablet display.

In addition, six electrodes are added to measure the conductivity between the handle the user is holding, the two tips of the chopsticks, and between the segments of a sectioned plate. In that way a number of actions can be estimated: chopsticks touch food on each of the sections of the plate; chopstick tips touch together; and chopstick tips touch the user's mouth.

In the prototype, the sensors are embedded in a 3D printed enclosure and are connected to an Arduino microcontroller. The sensor data provides input for the interactive tablet application using USB connection. A simple state diagram similar to the Sensing Fork [3] project allows us to understand behaviors such as "food dropped while going to mouth", "food in mouth" and "failed grasping attempt".

Easy Clap

The first game is to practice opening closing action and is inspired by the Guitar Hero game. Users have to close the tips of the chopsticks on the rhythm of the music. The aim of the game is to provide a playful way of practicing opening and closing actions.

The chopsticks pose is mirrored on the screen of the tablet and is augmented with instructions. As shown in the screenshots in Figure 3, after a short introduction, the music begins to play and the child will try to clap the chopsticks in time with the music and the falling of food onto the ground. If the child does a good a job in clapping the chopsticks at the right moment the word "Perfect!" will appear. If the child misses the right time to clap the chopsticks or attempts to cheat in the game by closing the chopstick at all times, then the word "Missed!" will appear instead of "Perfect!".

Easy Pick

The Easy Pick game is designed for more advanced chopstick learners and requires the control for picking up food and putting it in the mouth and thereby also - trains the eye-hand coordination.

Easy Pick consists of the segmented plate as shown in Figure 2. Foods of various difficulty level are positioned in the sections. In this game, the character will indicate which food that it wants to eat from the sectioned plate and the child has to pick up food from the section of the plate that contains the food that the character wants to eat without dropping the food.

The child will pick up the food from the section of the plate that contains the food that the character wants. When chopsticks reach the section of the plate then the

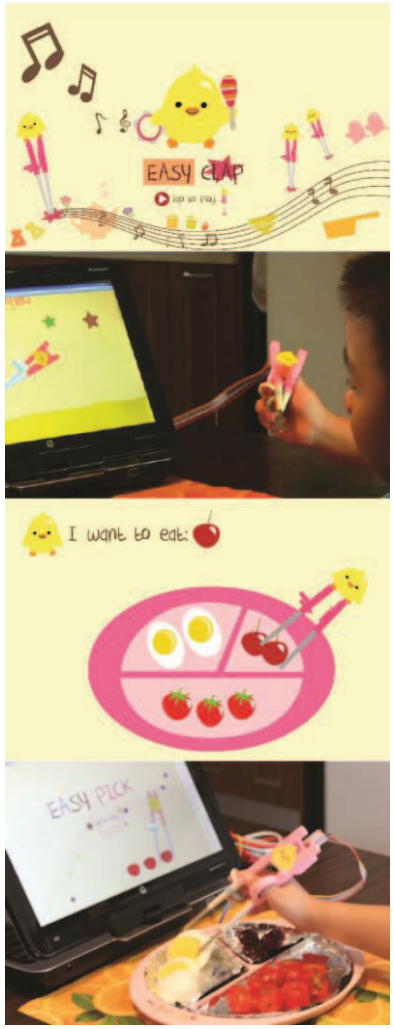

Figure 3. On the top the Easy Clap game in action, bottom images show the Easy Pick game.

virtual chopsticks in the game will also be positioned at the same section. Otherwise if the chopsticks reach the wrong section then the sentence "Please pick up the right food" will appear.

If the child drops the food before it reaches the mouth then the food in the game will be placed back onto the plate. When the child successfully places the food into his or her mouth, the character in the game will eat the food and the amount of food on the virtual plate will be reduced.

Discussion and Future Work

We presented the design and implementation of interactive chopsticks as a first step towards an interactive application that aims to help children develop eating skills.

Early feedback from a few users indicate that children and mothers love it. Although skill improvement is difficult to measure, our test subjects reported enjoying eating foods that they disliked before using the interactive chopsticks. A full user study is planned to establish the benefit of the system and to compare the augmented mirror approach to a condition that only augments the behavior with audio feedback.

Our current prototype is based on regular training chopsticks, future advanced versions are planned that measure opening angle with a bend sensor that does not need the training hinge. In addition this work can be expanded to the gamification of several other common household activities that require fine motor skills, such as using scissors, tying shoelaces and tooth brushing.

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