
Sensing Fork and Persuasive Game for Improving Eating Behavior

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ABSTRACT

We present a fork-type sensing device called the Sensing Fork that detects the eating behavior of children (food choice and eating actions), and a smartphone game to address children's eating problems based on their eating behavior. This paper describes the design and implementation of the Sensing Fork prototype and a play-based eating game called Hungry Panda 2, which works with the Sensing Fork. This game focuses on motivating children to eat all kinds of food on their table.

AUTHOR KEYWORDS

eating behavior; food recognition; gamification; mobile; sensing; persuasive computing; ubiquitous computing

ACM CLASSIFICATION KEYWORDS

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

INTRODUCTION

A well-balanced diet is an important factor in maintaining good health. Governments around the world are also promoting balanced diets [1], [2]. For example, in Japan, children learn proper nutritional balance in kindergarten or elementary school. Teachers instruct the children to eat diverse types of food during mealtimes.

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Various projects have been implemented to improve human activities, particularly eating behavior [3], [4], [5]. The Playful Tray targets slow-eating children using a dish-type display with visual feedback. The EaTherein is a fork-type device that targets the improvement of dietary habits for children using sound feedback. The Hapifork provides tactile feedback of quick-eating behavior based on the biting interval. However, neither of these systems detects eating behavior sufficiently owing to a limitation of sensors. We therefore developed a fork-type sensing device that infers what the user is eating by detecting the food color and conductivity [6]. However, calibration before starting the meal is required for successful food detection.

In this study, we aimed at devising a method to motivate children to eat all kinds of food on their table without the need for a calibration process. We focused

on the relative difference in food colors to estimate the food types: the system estimates the food type by comparing the color of the food to previously scanned colors. We also developed a new application called Hungry Panda 2, which helps children eat diverse types of food evenly without the requirement of a complicated calibration (Figure 1).

SENSING FORK DESIGN

As shown in Figure 2, the Sensing Fork embeds various miniature sensors including accelerometers, electrodes, and a color sensor. The color sensor detects the food color when the user pokes it. Three electrodes are located on the grip and on a pair of tines on the fork. These electrodes are used to detect the eating behavior of the user, such as biting and poking. The biting is detected using the grip and tine electrodes, which measure the conductivity through the user's hand, body, mouth, and food, whereas poking is detected



Figure 1: Overview of Sensing Fork and Hungry Panda 2 application

using the pair of fine electrodes, which measure the food conductivity. When an action is detected, the system triggers the color sensor to detect the food color.

The device also includes a Bluetooth module to send sensor data to a smartphone. A smartphone application then analyzes the sensor data and provides real-time feedback to encourage users to eat a balanced diet.

Based on the data from the Sensing Fork, the smartphone application detects the food colors and eating status. As shown in Figure 1, the smartphone also detects four eating statuses using the sensors described above: (1) **At-rest**: The fork is at rest and not held in hand. (2) **Holding**: The user is holding the fork in hand without any food on it. (3) **Poking**: The person is poking a food item and placing the fork's tines

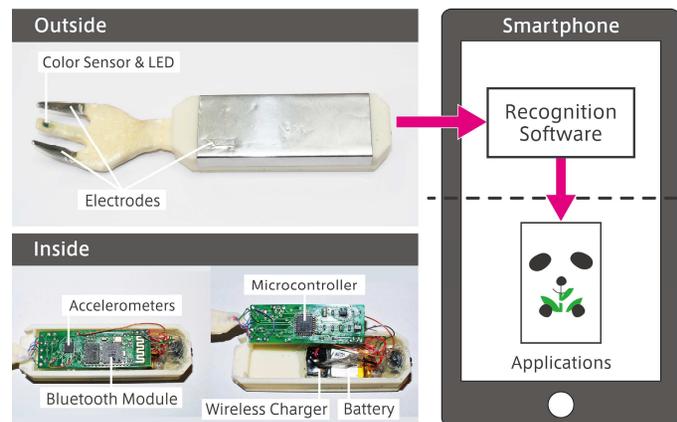


Figure 2: System configuration

Left: Prototype of Sensing Fork (L130 x W25 x H15 mm)

Right: Host software and applications on the smartphone

into the food. (4) **Biting**: The fork holding a food item is touching the mouth.

Thus, when a user pokes a food item, the system then activates the color sensor to distinguish the type of food.

EATING GAME: HUNGRY PANDA 2

We developed a play-based eating game called Hungry Panda 2 to persuade children to eat a variety of food types for healthy living, and to be used with the Sensing Fork (Figure 1). This application aims at resolving two eating problems: (1) **Picky Eating**: The score (expressed as bamboo grass points) goes up when the user eats food with a different color. This function aims at motivating children to eat many kinds of food for a higher score. (2) **Distraction**: The system sounds an alert when the user stops eating (**At-rest/Holding/Biting**) for a certain time period during mealtime. This function aims at helping children focus on the meal itself.

To motivate children to eat a balanced intake of food and concentrate during mealtime, we designed the game to utilize a hungry panda as a virtual pet. The panda imitates the same eating behavior as the child, such as holding and biting their food. We hope that children will feel empathy for the panda. Figure 3 shows eight screenshots of the game and the corresponding Sensing Fork status:

1. First, the panda appears sad and says "I am the Hungry Panda, I am hungry" until the child starts eating (**At-rest/Holding**).
2. When the child pokes the food, the panda holds bamboo grass with the same color as the food as visual feedback (**Poking**).

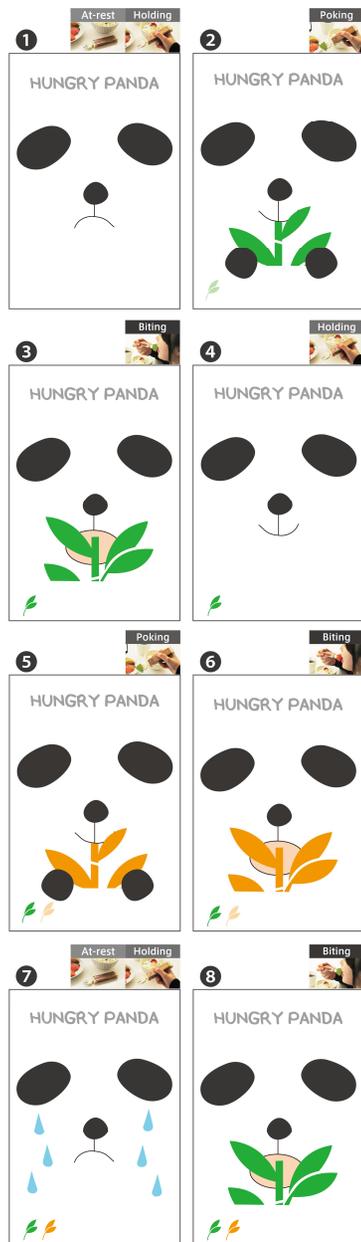


Figure 3: Steps of game application

3. When the child bites the food, the panda also eats the bamboo grass and says “yummy” as aural feedback (**Biting**).
4. When the fork status changes to “Holding”, the panda obtains a score and smiles (**Holding**).
5. Similarly, when the child pokes another food, the panda holds a new bamboo grass (**Poking**).
6. When the child bites this food, the panda also eats the grass and speaks (**Biting**).
7. When the child suspends their eating (i.e., the Sensing Fork is placed on the table, or the child does not eat anything for a few minutes), the panda cries and says “I want to eat more” (**At-rest/Holding**).
8. When the child bites the first food again, the panda eats new bamboo grass with the same color as the first bamboo grass. However, the panda does not get extra bamboo points, but says “I want to eat a different food” to stimulate the child to eat diverse types of food (**Biting**).

Thus, this game provides visual and aural feedback based on the child’s eating behavior detected by the Sensing Fork, and applies a gamification concept [7] to help the child’s dietary education during mealtimes. In addition to the above reward (bamboo grass points) given by the system, the child may have the motivation to eat all of their food, and the parents may give external rewards (e.g., sweets) based on the improvement of the child’s eating behavior.

CONCLUSION AND FUTURE WORKS

This study presents the design and implementation of the Sensing Fork, which automatically recognizes the user’s eating behavior. To encourage good eating behavior, we designed and prototyped the Hungry

Panda 2. Now, we have begun performance experiment to improve recognition rate of various foods. As future research, we will also conduct user studies in an actual home with children to determine how well the Sensing Fork and Hungry Panda game work in improving a child’s eating behavior.

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