Food Media: Interactive Entertainment Over Telepresent Dinner

Jun Wei, Adrian David Cheok, & Shengdong Zhao

Abstract— **Food has always been a social hub; as the chances for remote families to enjoy shared entertainment are decreasing greatly nowadays, we propose "Food Media" as an intuitive multimodal platform to engage remote people within the telepresent family dinner context. It is an exploration of appropriating food and food activities as a medium for family communication and entertainment. Rather than fancy digitalized multimedia or games, this system breathes interactive entertainment into domestic routine activity of family dining, introducing multi-sensory interactions like touch, smell and taste, to connect and entertain people over a natural and playful eating experience.**

1. Introduction

As advanced technology is improving daily life with more convenience and higher efficiency, family relationships are going through a radical transformation. As a result of the modern speedy lifestyle, most people are away from their family members, thus rarely have opportunities for shared family entertainment. On the other hand, the digital communication channels like Internet chat, video games and social network services are becoming the mainstream entertainment among young people, leaving the old generation socially isolated from the home social circle.

Undoubtedly, the introduction of entertainment technologies into the home is changing the dynamics of family life and has larger social effect at the same time. Entertainment is a key driver in the development of technology. Social and physical interactions are the new paradigms that outline a vision for the next generation of entertainment systems [1]. From this viewpoint, we believe the convergence of new devices would provide promising channels for enriched entertainment. In this paper, we introduce "Food Media", a novel paradigm to derive playful experience from people's everyday activities. Appropriating the sociality and physicality of food and dining activities, "Food Media" concept envisions the intuitive and playful multimodal interaction built upon family dinner situation would contribute greatly to enrich the entertainment experience and reconnect family members, across generations and over a distance.

Based on the proposed "Food Media" paradigm, a prototype with embedded computerized devices was

designed and implemented (Fig. 1). The prototype supports multiple interaction modalities around food to afford the enjoyable social interactions: Magic Table Surface to move the partner's dishes remotely; Animated Tablecloth to display fancy message on fabric; and *FoodieFab* to teleport digitally designed patterns or messages using real edible food. All these interactions are integrated seamlessly into the telepresent dining environment and achieved through the natural hand gesture in front of the screen. In this context, food becomes a valuable asset in the computer-mediated entertainment. While experiencing the telepresence communication, users become engaged into this playful interaction over food and dining. This system is expected as an exploration of family-centred interactions, employing playful interactions to strengthen the relationship between children, adults, and the elderly.
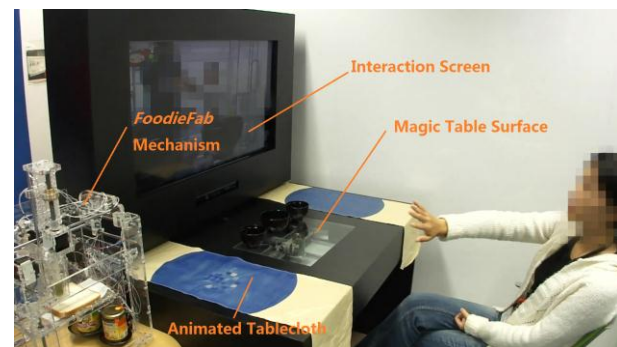

Fig. 1 Overview of the integrated system

Playfulness can be merged into human activities in various ways, and designing for playfulness involves creating objects that elicit a playful approach and provide enjoyable experiences [2]. The contribution of this work lies in the pursuit of a new direction in communication tools for remote families, in which people are engaged into the natural dining activities for enriched social entertainment. What's more, senses other than video and audio are involved, such as touch, smell and taste, to support more natural and tangible forms of interaction. This paper targets the mealtime situation and explores the interweaving forms with functional, sociable, emotional and playful aspects of this family entertainment medium.

The remaining paper is organized as follows. Section 2 introduces the background and related work around interactive entertainment through food. Section 3 explains the process of system design, followed by detailed description in section 4. Then, section 5 reports an initial evaluation with public users, and section 6 concludes by

discussing future work on developing domestic media for enjoyable social interactions out of routine activities.

2. Background and Related Work

As families become more geographically distributed, new trends of technology adoption are emerging around the topic of family communication [3]. Domestic life is currently a new targeted environment of sociality and entertainment for advanced technology applications.

In parallel, the entertainment computing industry has experienced exponential growth over the last few years and has also attracted many researchers to this field [4]. Entertainment is becoming a crucial element of domestic communication, and many interactive technologies have been developed that support enriched entertainment communication in domestic life.

While it is necessary to have family entertainment during leisure time through both traditional and new channels, this perspective depends heavily on external devices, which misses out the potentials for people to make entertainment out of their everyday accomplishments. Moreover, the inevitable transformation into the modern lifestyle has been making it more challenging for people to achieve agreeable schedule for shared leisure time, not even locally, let alone for remote families.

Due to these limitations, we believe there is an opportunity to create new medium to engage people, including children, adults and elderly, into the natural playful interaction, and socialize them in an easygoing and compelling way. Entertainment is also a major component of social interaction that occurs through routine activities. Routines are the glue that holds a family together.

Specifically, dinnertime is a unique happening in family life, beyond food consuming, it's for social communication and entertainment among family members as well. Family dinner event has been regarded as a cultural custom in many countries. Furthermore, individuals interact through and around food; pleasure and family connectedness are included among the several positive aspects of people's interaction with food [5].

These viewpoints verify the potentials of using food as a novel but intuitive medium to provide enhanced interaction and playful experience. There have also been some explorations towards embedding food with various computing technology, for meaningful interaction, social entertainment and education as well. DinnerWare [6] is an exploration of eating as a medium for computation and aesthetic expression. It consists of a dining service electronically equipped to react to the properties of the food and respond to a user's gestures. Gamelunch [7], a sonically augmented dining table, maps the usual dining actions like cutting and slicing onto physically-based sound synthesis. Playful Tray is embedded with an interactive game play over a weight-sensitive tray surface, to recognize and track the natural eating actions of children in real time, using children's eating actions as game inputs for reducing their poor eating behaviours [8]. The e-Care table is designed as an interactive and educational tool for family leisure and educational activity [9]. MunchCrunch is another heath trivia team game designed to be both entertaining and educational to encourage healthy eating [10].

While these perspectives have their merits in enhancing the interaction and enjoyment, this paper adopts a different perspective by focusing on deriving entertainment from routine family dinner, to produce a novel and intriguing mealtime experience. "Food Media" brings family members from different households into the shared and playful interactions over food and dining, going beyond the unnatural situation of telepresent dining.

3. Design

Considering design of playfulness, the domain of playfulness is much broader than just games: potentially any activity can be approached and performed in a playful manner [2]. The approach to merge social entertainment into people's routine activities, while incorporating multimodal interactions and multi-sensory experience makes our system different from other existing projects on family communication and entertainment. Making creative use of the resources that people have available to them in carrying out their activities (in this instance, dining), is likely to be seen as something that gives them the ability to be playful: standardizing methods of action are likely to lead to diminished effectiveness in communication, but also an impoverished leisure experience as there is little opportunity for people to make entertainment out of their everyday accomplishments [11].
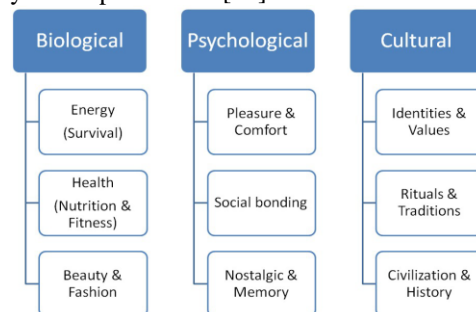

Fig. 2 Main categories for functions of food

Food is a crucial resource available to us. Food is pervasive. Biologically, humans need food to survive and get energy. Beyond that, food consuming is also in the fabric of people's daily life, and is charged with intense and complex relationship with people's emotional feelings. To design family entertainment from food, we took an overview of food and the associated key activities. We categorized the functions of food into three main groups: biological, psychological and cultural, reaching from individual to social level, and finally racial level. However, these three functions are not mutual exclusive, but are interrelated with each other in different manners. And each function can be extended to different levels, shown in Fig. 2. For the psychological function, the emotional feelings can be derived from food itself, or during the food-related activities (Fig. 3).
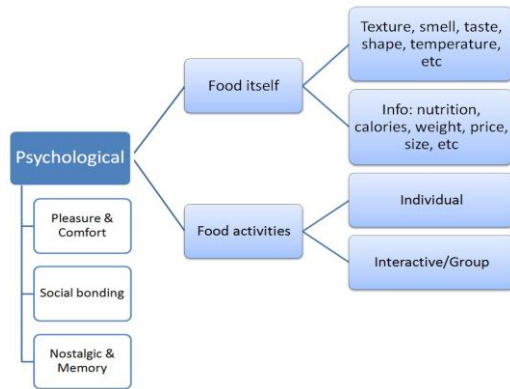
Fig. 3 composition for psychological function of food

At the same time, food is not standalone but related to a series of activities. The pool of food activities encapsulate the broad spectrum from planting to serving, and the main target ones for technological enhancement include storage, selection, preparation, cooking, eating, serving and sharing. Various technologies have been applied into different stages of food-related activities, either to enhance the efficiency or enjoyment of food experience.

From the analysis of food, we can tell that eating is one of the key activities people valued much about food. The concept of "Food Media" adopts the strategy of using family mealtime as a potential platform for family communication and entertainment. Evolving technological ability to create computer-mediated entertainment, "Food Media" is not only expected to facilitate people's communications for keeping relationships closely and the sharing of their taste experiences, but also to enhance and sustain communication between remotely-located peoples with more emotional and soft communication ways.

Built upon the paradigm, the prototype was designed to support a series of intuitive activities around food in family dinner situation. With integrated sensing and computation, the system allows artefacts in one dining space to reflect and respond to the other at a distant location, enabling video chatting, gesture interaction, mutual food serving, animated fabric displaying, and food teleportation to enrich the natural and affective communication between two remote households. We intend to encourage close and emotionally communication between remote people through "food media" while enjoying the pleasurable eating experiences.

As explained in Fig. 4, these activities on one side are controlled by the interaction screen and transmitted to a remote location via the Internet. The Interaction Screen works as the hub of the system, enabling the real-time interaction between the remote users, and supports both gesture and video communication. All the subordinate mechanisms, including the magic table surface, animated tablecloth and *FoodieFab* modules are connected with and controlled by the Interaction Screen wirelessly through Bluetooth. While experiencing the telepresent dinner, people can move their hands towards the screen, choosing icons on the screen to initiate different playful interaction channels. User's hand would be tracked and the chosen icon signal would be transmitted across the Internet to the paired system in another location. This triggers the corresponding

mechanism to move dishes magically, to display animated pattern on tablecloth, or create edible food on the other side.
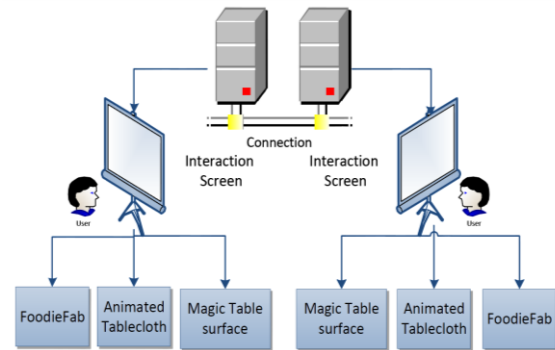

Fig. 4 System configuration of Food Media

Beyond the basic dining, this system provides a wider range of channels for expression and interaction, to engage people into the playful remote dining. The scope of this research is not primarily to invent a separated communication tool, but rather to support and enrich remote interaction upon dining activities, merging entertainment communication with routine social behaviors.

4. System Description

In this section, we will go through the detailed design and implementation of each subordinate mechanism, and explain how they integrated together to support the shared entertainment experience. In the prototype, we designed 7 activities around food categorized into the three channels of interaction, represented by 7 icons on the screen.

The Interaction Screen is a normal monitor embedded with a video camera and Kinect Sensor[1]. Through the system, human to human communication is achieved through the gesture interaction with the screen, by allowing the user to easily select the activities he/she wants to perform while dining. The Interactive Screen module includes a Kinect sensor bar and gesture-based on-screen menu selection. The stereoscopic 3D camera embedded into Kinect is used to capture and compute the depth of the current frame image. A gesture-based selection allows the user to easily select and perform the actions on the remote side. The gesture detection is achieved by using a Kinect sensor bar, the OpenNI[2] 1.0.0 API and PrimeSense's[3] NITE 1.3.0 Middleware. Besides the hand tracking and gesture recognition, different colors have been mapped to different cursor states to improve the user's understanding of what is currently happening.

A. Table Surface- Move remote dish magically

Considering one of the positive aspects about dinner interaction, we designed the mutual food serving activity to provide the warm sense of pleasure and intimacy. As serving food is a traditional manner to show respect, love and care to family members, we attempt to bring back this

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[1] http://www.xbox.com/kinect
[2] http://www.openni.org
[3] http://www.primesense.com

social table etiquette in family dinner using this mechanism, even when people fail to share the same dining location.

The mechanism applies the basic principle of magnetic attraction, combined with two-axis linear movement. Permanent magnets are attached on the bottom of the dishes. The whole set of structure is put underneath the table surface and then covered by a piece of glass. Movements of motors, electromagnet's activation and data communication with the screen are controlled by the master board, embedded with Bluetooth. When the master controller receives the activation signal, the motors and magnets would execute the remote moving of dish, which gives a visual illusion of "magical moving" on the table surface.

This mechanism is assembled as part of the dining table and totally integrated with a visual interface through Bluetooth protocol, achieving a user-friendly interactive experience based on gesture. When user on the other side selects one of the dish icons from the screen, the electro-magnet will move directly to the position of that dish, activate the magnet, and drag that dish smoothly towards the user on the table surface. This remote movement of physical dinnerware during dining provides an intuitive channel for playful interaction and conveys more delicate human emotions at the same time.

B. Tablecloth - Transmit animation on fabric

The animated tablecloth extends the communication to another component of dining environment, the tablecloth, which is augmented into an interactive platform for remote interaction. By introducing the dynamical and interactive colour-changing, the communication around dining is enhanced further.
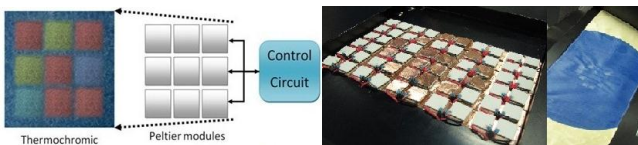

Fig. 5 Principle and matrix arrangement of Peltiers of the tablecloth display

The tablecloth is implemented to display various graphics or slow-rate animations through controlled colour changing on fabric. To achieve this, we are currently using thermo chromic inks combined with Peltier semiconductor elements. The basic structure is depicted in Fig. 5. The tablecloth combines Peltier semiconductor modules and thermo chromic leuco dye ink technologies using a closed loop control system, employing a PI (proportional, integral) controller in order to accurately control the colour. The current inks actuate at 32 degrees (colourless) and regain the original colour of brown at 24 degrees. Peltier elements can reverse their function from heating to cooling or vice versa by reversing the polarity of the supply voltage. This allows both heating and cooling of the fabric dynamically, to achieve a subtle and fast animation effect.

In the current implementation, a pixel display mechanism is applied to achieve accurate display of various patterns. As shown in Fig. 5, 60 Peltier modules (1.5cm*1.5cm each) are arranged in a 6x10 pixel display pattern. Fifteen control circuits with each circuit individually controlling four

Peltiers are connected to a master controller using I2C protocol. Each controller uses a single microcontroller with the internal oscillator running at 8MHz. Four PWM (Pulse-width-modulation) signals are generated using internal timer interrupts at 100Hz. The duty cycle of each PWM signal controlled by the PID (proportional, integral, derivative) module implemented in the microcontroller with the four temperature feedbacks. In this way each of the four Peltiers is accurately controlled for temperature using a single controller circuit. Once the display patterns are received, the master controller issues commands to each of the control circuits to turn on or off one or one set of Peltiers according to the specific pattern.

This animated tablecloth provides another appealing channel for emotion expression and playful interaction in a tangible way. Receiving the animated display physically stimulates the enhanced feeling of ubiquity, far beyond the plain text or words, and contributes to the entertainment experience between family members as well.

C. FoodieFab- Teleport edible message

FoodieFab is another channel to allow human-to-human interaction through edible food, which incorporates the multi-sensory interaction of smell and taste. Cooking and sharing food is an important social activity to enhance family intimacy, and people always have pleasant feelings when enjoy food prepared by their parents or grandparents. FoodieFab recreates this sensational activity for remote family members, by allowing people to design their customized message, and teleport it to remote partner, presented with edible food material. With FoodieFab, even the commonplace food serve as a rich means of expression.

This food-teleport activity is also initiated by gesture interaction with the screen. User identifies his preferred pattern on the screen, and then the command will be transmitted to remote location, and triggers the mechanism to fabricate the received digital pattern in edible food. The pattern can be designed as various emoticons, private greetings, or short messages, and presented to their loved ones not only as a gift physically, but also as sentimental expression of care and intimacy.

Moreover, the mechanism is designed to craft with multiple food materials, the attempt is not only to make the food message colourful visually and more tasty, but also enable the creation of contextual expressions through changed color, smell and flavor, to represent different emotions or feelings. Food here is the multisensory medium for affective communication, and each flavour can be translated into a corresponding emotional state or special experience from one's memory. We believe the transmitting of self-designed exclusive food not only resembles the traditional social activity of sharing food during family dining, but also acts as an interactive and playful activity to engage remote families in physical world.

This mechanism works as another output channel from the screen interaction. The mechanical structure is designed to use 3-degree freedom robotic carriage to move the food depositing component along the x and y axis and the platform up and down to form z coordinate. The accurate

and smooth movement of each axis is achieved through lead-screw coupling powered by step motor, controlled by microchip from the master board (Fig. 6).

Fig. 6 (Left) *FoodieFab* mechanism with example output (Right) Design of master board

Through the real-time wireless communication with the screen interface, the pattern composed by the user will be interpreted and sent to the mechanism, indicating the starting point and the continuous motion path. In this way, the digitally designed pattern is to be reproduced layer by layer using real edible food physically. Through this layered printing, a piece of food message would be constructed.

Integrated into the "Food Media" system, people can achieve affective message transmission either by printing the chocolate-made message on a piece of toast located in their grandparents' kitchen, or teleport a muffin with different food materials in each layer to express their indescribable feeling. The richness of message content was much increased with the inclusion of other senses like colour, image, even smell and taste, not only because they provide a richer, multisensory description of reality, but because the elements together provided more possibilities for interpretation: emotion, mood and humour [12]. The design and transmission of food-made artefacts are quite promising to contribute to the playfulness of remote dinner activities. Through *FoodieFab*, the common food is not only shared with remote families physically, but also implicitly personalized, in an interactive and playful way.

D. Results

Based on the mechanical design, we implement the table surface mechanism as shown in Fig. 7(Left). Considering the normal dining area on table, we designed the attached electromagnet component to move within a range of 300mm and 400mm respectively in x and y dimensions. For initial position recognition and accidental oversteps, optical limit switches were mounted on both axes to interrupt the moving when necessary. Considering suitable speed and smoothness of movement to simulate the natural feeling, glass-made surface was finally used to reduce friction and avoid wiggling effect. Accordingly, we designed the moving speed as 16mm/sec in both x and y dimensions to keep balance between the speed and the magnetic holding force.
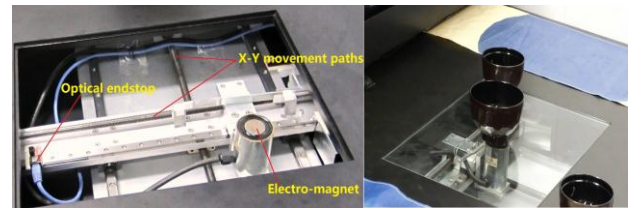

Fig. 7 (Left) Implementation of Table Surface (Right) Screenshot from the actual movement of remote bowls
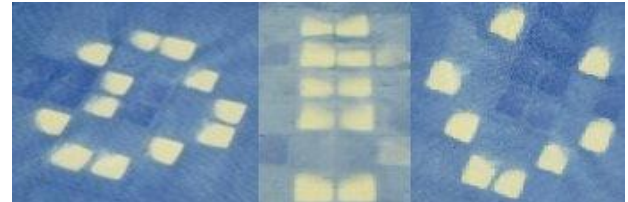

Fig. 8 Patterns display on Animated Tablecloth: (Left) Heart (Mid) Exclamation mark (Right) Smiley

As for the animated tablecloth, the quality of response for Peltier element is essential to achieve animated display and pattern changing accurately. As observed in the experiment, the rise time of the system is approximately 1.5s (to go from ambient temperature of 25 to 32 degrees). In addition, the cooling also takes approximately 1.5s which is important for allowing subtle bidirectional animations on fabric. Based on the pixel display pattern, three different animated patterns were designed and implemented, as shown in Fig. 8, which were represented by 3 icons on the interaction screen.

Regarding the *FoodieFab* mechanism, a range of factors may influence the outcome of food crafting. The parameters include the diameter of syringe pinhead, coordinate speed of the 3-axis moving motors with piston pushing motor, as well as the distance between food crafting platform and food droplet, etc. Besides, the characteristics of the food also need be considered carefully to achieve accurate crafting, such as the viscosity and density of different foods materials at different temperatures.

Experiments were conducted iteratively to identify the suitable food ingredients, matched with different sizes of syringe pinhead. A range of foods are available for this application, such as chocolate cream (pure black, white and milk chocolate), kaya jam, peanut cream, etc. Some of them need to be heat up and melt down, and some of them can be used directly. Among them, we chose kaya jam to fine-tune the parameters iteratively. With the finalized parameters, the mechanism was designed to craft with the speed of 5mm/s-7.2mm/s, and achieved the resolution of 1-2mm. Fig. 9 presents one of the results during the adjusting process.
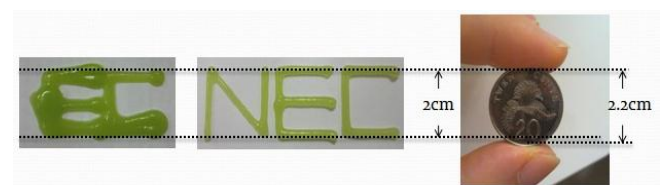

Fig. 9 Improved resolution achieved through matched moving speed

As an integrated system, the "Food Media" prototype provides a series of intuitive and interactive activities under

dining context to enhance family communication and entertainment through embodied food. Engagement into these activities would potentially contribute to the social entertainment during a pleasant dinner remotely.

5.   User Evaluation

Based on the implemented prototype, we carried out user evaluation through a survey conducted in an open demonstration to elicit people's opinions regarding traditional family dinner and this computerized prototype. The system was settled in a room-like environment (Fig. 10) during a local exhibition event in Singapore with the theme of "Future Home", which is accessible to the open public and free of charge.

Fig. 10 System set up in the local demonstration event

Surveys were sent out to the visitors' emails right after the event, and we got 17 responds. The survey collected user's demographic information like gender, age range, marital status, family dinner habit, together with rated satisfaction level (from 1 to 7) regarding 8 statements. Among the 17 respondents, 6 were male and 10 female (one did not indicate); their ages ranged from below 25 to about 65 (47% below 25 years old, 24% aged 25-35); 65% of them were single, and 76% live together with family.

The eight statements were designed to evaluate the users' satisfaction level regarding the system's emotional effectiveness like the sense of being together, entertainment, engagement, happiness, etc, and ease of use, totally from end user's point of view. Generally, respondents' feedbacks were quite positive, which are presented in detail below.
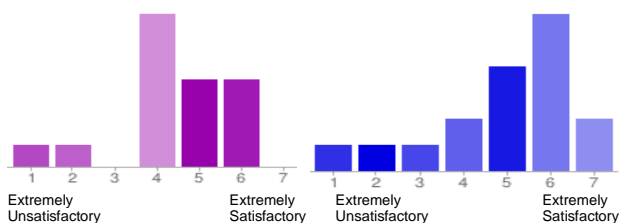

Fig. 11 (Left) the system increases my feeling that I am being together with my family members even though we may be in different places (Right) the system increases the entertainment of family dinner
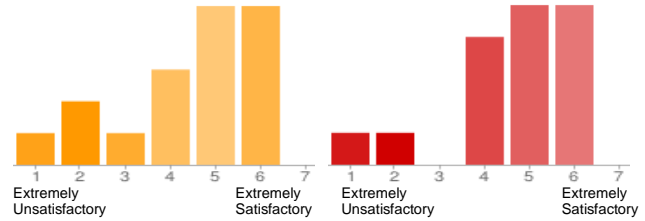

Fig. 12 (Left) the system makes me feel more positive emotion (Right) the system makes me more engaged into family dinner
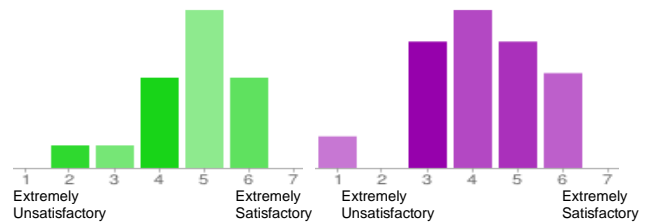

Fig. 13 (Left) the system is easy to use for me (Right) the system makes me feel more connected and intimate with my family
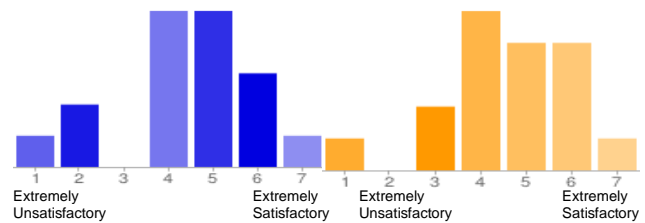

Fig. 14 (Left) the system makes me feel surprised but happy (Right) the system can help to improve family relationship

From the feedbacks, we infer that the majority of respondents agreed with that the system can help to provide improved family bonding and increased entertainment experience through interactive dining. Comparatively, users are more confident on the ratings of emotional responses (entertainment, happiness, surprise, etc) than co-present feeling and ease of use. The possible reason may be the indirectness of evaluating the sense of "being together", since it is a relatively new concept for normal people, which may turn out to be more difficult for them to tell.

The exhibition presented visitors with various technological applications that may emerge in people's future home, which provided a great opportunity for normal non-tech people to experience them as potential consumers and share their personal opinions with designers and developers. The eight statements we included in the survey tried to get an initial idea about people's perceptions of this new interaction medium settled at domestic space. This information can be helpful for us to improve the system design following the user-centred design approach.

6.   Conclusion

In this paper, we introduced the "Food Media" project, an exploration of how digital media and food could be integrated and incorporated into ordinary households and family life to afford shared enjoyment experience. Normally, food brings people together for communication and social fun. People are familiar with food, and food

sharing is natural among intimate people. Appropriating food as a novel interactive medium for remote communication and entertainment, "Food Media" encompasses multiple interaction modalities around food and dinnerware, which enables playfulness not in leisure time, but into routine activities of family life, turning remote dining into interactive playful experience.

A prototype embedded with various interactive subsystems was designed, implemented, and evaluated. It augmented and transported the experience of communal family dining. Through these interactive activities during telepresent dining, including moving dishes remotely, transmitting animated textile display and teleporting edible message, this system hopes to provide a new platform to enhance communication and pleasure of family dinner, across generations and over a distance.

Homes are a distinct domain for entertainment, and media spaces can span a wider range than traditional TV, movie and games. The notion of entertainment we attempt to convey here is not something that is funny in itself, but is conducted in a playful manner to entertain people. While many other forms of entertainment heavily rely on human factors to enhance the joyful interaction experience, our approach incorporates social interaction as an integral part of the entertainment experience.

The research into how household technology can be embedded into everyday artefacts for enhanced meaningful interaction and entertainment indicates the promising area of design novel media space for family entertainment. In the future, more interaction channels can be included to increase the feelings of connectedness, awareness and playfulness, to enhance the shared social entertainment experience beyond verbal or video communication.

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