

A Musical Feast

How Musical Performance Using Playful Utensils Can Enrich the Cooking and Dining Experience

Cao Yan Yan
 Graduate School of Media Design
 Keio University
 Yokohama, Japan
 yanyan.cao@gmail.com

Jeffrey Tzu Kwan Valino Koh
 NGS, Keio-NUS CUTECenter
 National University of Singapore
 Singapore
 jtkv.koh@gmail.com

Abstract-Playful Utensils is a system of music-enabled, eating and food preparation utensils that facilitate light-hearted interaction and communication in the kitchen and dining room both locally and remotely. In order to understand the use of utensils to support communal behavior in dining situations, three design studies were conducted. Addressing the need for a new direction for food research in HCI, Playful Utensils aims to draw attention away from contemporary kitchen and dining media research, which focuses too acutely on ubiquitous sensory overload, to make apparent the need for socially communicative, emotional assets investment regarding communities in the kitchen and dining space.

Keywords-dining; playfulness; performance

I. INTRODUCTION

Appearing to be and functioning as everyday household cooking and dining utensils such as forks, knives, spoons and chopsticks, Playful Utensils is a system of music-enabled, eating and food preparation utensils that facilitate light-hearted interaction and communication in the kitchen and dining room. When Playful Utensils are activated, they create a ubiquitous wireless mesh network in which each utensil talks to one another via a host server. This enables the musically augmented utensils to be orchestrated by family members at the dinner table or remote locations. The light-hearted interactions will enrich cooking and dining experience and enhance emotional connections among family members.

Traditionally, in Asian households, the kitchen and dining room has been a place for families to connect and engage with one another, yet today's accelerated lifestyle endangers such nurturing activities. The generation gap between children, adults and the elderly is ever increasing, partly due to the fact that the experience of communal cooking and dining by adults is often at odds with

the technological pursuits of children. The desire to revive nostalgic sharing among family in modern domestic space poses new challenges and requirements [1, 2, 3].

You might remember playing drums with your chopsticks and bowl and getting a slap from your mother, but many cultures, in fact, practice performative eating and dining and Asian cultures are no exception. We only need to look to Korean Nanta and Japanese Teppanyaki to see that playful cooking and dining has been nurtured by the diversity of Asian cultures and is alive and thriving, sometimes even facilitating big business. Not only do such practices improve the communication between all participants, but it also makes food actually taste better; at least, in a psychosomatic way, as the people involved enjoy the company of one another on a dimension that transcends the basic and sometimes mundane activity of cooking and eating [4].

What if playful interaction was introduced as a new behavioral model to improve communication between children, adults and the elderly within the kitchen and dining room at home? Playful Utensils aims to be a system to promote interaction between members of the family who experience such a generation gap. Everyday cooking and dining utensils become intuitive musical instruments so that the very act of eating and food preparation becomes fun and communally interactive for the whole family.

Working in tandem, a collection of Playful Utensils becomes an orchestra of harmonious, generative musical instruments in which the whole family can play with. Using the traditional and intuitive actions that each utensil was purposely built to function as, ambient dining music can be created adding a new dimension to

family-centered interaction in a communal and playful way. This method of playful interaction aims to improve the communication and enjoyment of preparing and eating food in the family household.

The paper is presented in eight sections. In Section II, we presented our motivation along with related works in cooking and domestic space. We present key feature and novelty of Playful Utensils in Section III and show details of three qualitative user studies in Section IV. Section V describes current design and implementation of Playful Utensils, followed by future work and possible scenarios in Section VI, with major contribution of research described in final Section VII.

II. MOTIVATION AND RELATED WORKS

Rich and robust telecommunication tools such as mobile phone technology, audio/video online chat and email have facilitated our mastery of audio and visual communication. Yet even with these systems in place, we still have some difficulty choosing what to talk about. “Small talk” and discussion about the weather can only take a conversation so far. By injecting light-hearted playful and educational activities into an online conversation, it is our hopes to further engage people, especially within remote communications situations that include cross-generational relationships.

Many works in domestic space involve exploration with robotic cooking assistants, but they do not address the need for interpersonal relationships in regards to the preparation of food, nor the sharing of recipes, meals and traditions across generations [17]. Numerous projects address the need for contextually rich information while cooking without addressing the need for building social capital nor facilitating family intergenerational bonding [5]. These could overload the user with superfluous data. Other systems provide the technology needed to achieve what Playful Utensils aims to do, but does not provide an adequate application in order facilitate family and intergenerational bonding.

Digital media is seemingly rebounding in regards to its shift from the digital and ephemeral, back to the physical and tangible [10, 14, 15]. Synesthetic and multimodal implementations to

improve memory have been proposed for augmented object interaction and the television [12], yet sound still continues to be illusive in regards to navigation and accessibility [18]. Yet there is no doubt that sound can enhance family remembering [9].

Other studies include the need to address the heritage of cooking and recipe transmission practice, but most of the time cooking is seen as laborious and often outside the domain of entertainment in many households, leaving young people without the necessary skills to equip themselves for independence [13, 16].

The Playful Toothbrush system developed at the National Taiwan University is most similar to our offering by presenting the user with the opportunity to be persuaded into better habits using ubiquitous computing [7]. Our system also has persuasive qualities, but is geared more towards collaborative interaction between many people, where as Playful Toothbrush concentrates more on the individual user.

Our system aims to build upon all these works in order to address issues of interpersonal relationships in families, activity and alternative means of learning, and address the new direction for food research in HCI [11].

III. KEY FEATURE OF PLAYFUL UTENSILS

A. Playfulness

Mostly referring to animals, the psychologist Gordon M. Burghardt (1984) outlined a working set of characteristics for play [6]. He mentioned among other things that play:

- Has a pleasing effect
- Is sequentially variable
- Is stimulus seeking
- Is quick and energetically expensive behavior
- Involves exaggerated incompetent or awkward movements
- Is most prevalent in juveniles
- Has special “play” signals
- Has a background role in relationships
- Is marked by a relative absence of threat or sub-mission
- Is marked by a relative absence of final consummatory behavior.

Most of his work was derived from the observation of animals, but at least some of these

characteristics for play can be applied to the way human beings play. Although children and adults alike can sometimes be seen as “messy beasts” if they do not observe the proper table manners, most of the time children at play can be seen as quite graceful, if you are not the one doing the cleaning up, that is [8].

For the purposes of Playful Utensils, Burghardt’s characteristics of play outline a possibly revolutionary way to socialize at the dinner table. Children love to play and although they may not admit it, adults like to play just as much. Studies have shown that mothers often signal children as young as 3 months that it is time to play [19]. Playful interactions strengthen the bond between children and adults, so it would only make sense that this type of playful understanding could be expressed when using Playful Utensils.

B. Learn by Object

Think back to when you first purchased the mobile phone that is sitting in your pocket. The chances that you actually read the instruction manual for that phone is probably pretty low, unless you work for IEEE or derive enjoyment from comparing low-level technical specifications. A more likely scenario is that you probably learned how to use said phone by pressing some buttons, exploring the menus, generally ignoring the user’s manual, and poked, prodded and played your way to an understanding with the device until you learned enough to satisfy your need of knowledge regarding its functionality relevant to your context.

For children, playing is one of the most effective ways to learn all sorts of useful knowledge. Any object has the potential to teach a myriad of things and children can transform anything into a toy. By using a tangible set of objects, Playful Utensils not only offers an analogue way to learn about cuisine and music, but also teaches children how to interact in tandem, with one another and even with their sometimes less imaginative, adult counterparts. Co-operation is one of the main learning features in the Playful Utensil system and with this tool, children have the chance to teach adults as well as learn from them.

Speaking of adults, for most of us, objects that were once filled with playfulness fade away into

the depths of functionality. These everyday objects become invisible until we need them to perform a specific task. By redesigning not only the objects but also the way adults use these objects, we can make something that both children and adults can play with. Even the elderly could benefit from the stimulation that Playful Utensils could provide, as the mere act of eating would activate the system and the interactions designed around it using minimal energy. If grandma had a chance to rock-out with her knife and fork while negotiating her pork-chops, mashed potatoes and green peas, everyone at the dinner table would have a good time.

C. Tools for Knowledge Sharing & Healthy Eating

As a tool, Playful Utensils can be used to associate healthier meals with favourite songs. This could be used to promote nutrition for say, children who do not want to eat their broccoli. By pairing favourite and fun songs with particular dishes in a meal, parents can add another dimension to dining in order to promote healthier eating.

As a learning objective, parents could also pass on the knowledge of certain recipes that would only normally be conveyed through word-of-mouth. Bringing children into the kitchen in the first place is hard enough, but by making the activity of food preparation and cooking more engaging and entertaining, teaching a child or teen how to compose a particular dish could be assisted by an associated song. People could eventually learn how to prepare all sorts of dishes based on the songs that are produced from a recipe.

D. Simple Functions for Complex Lifestyles

Video games such as RedOctane’s Guitar Hero [20] and Harmonix Music System’s Rockband [21] have successfully merged the activities of musical performance and gaming to entice new and meaningful ways for people to interact and engage with technology and one another. Much like a collection of instruments can play compositions collectively as an orchestra, in the Playful Utensils system each utensil has a simple function but when used in tandem can produce recipes and dining experiences of exponential variety.

The arrangement of musical notation can be treated as a recipe to cook a song. A food recipe can be seen as the sheet music to orchestrate a meal. For Playful Utensils, these two linear formulas are interchangeable in a way so that everyday dishes can be prepared and eaten in regards to what songs the family wishes to re-enact. In a similar fashion, picking a favourite song to play together becomes associated with a favourite dish or meal.

Much like the movements in an opera, courses of a meal could also be seen as operatic chapters. As the courses of a meal progress, new movements in the harmony could act as markers for a meals' development.

E. How to Make & Orchestrate? Other Instrument in the Family?

A fork is used differently, then a spoon, compared to a knife and so on. By analysing the basic uses and functions of each utensil we can begin to extrapolate a set of triggers based on natural uses specific to the utensil and how they are used for particular eating situations. For instance, one would use chopsticks to eat rice from a bowl in a specific manner that is unique to that action. Eating noodles with the same set of chopsticks in turn expresses a different way to use them, thus offering another dimension of harmonic music triggering.

F. Music Generation

Of course, any musician will tell you that actually playing the piano, violin or any other instrument well takes a lifetime of practice and hard work. The initial model of Playful Utensils is not meant to be a pure musical instrument in this respect, as the learning curve for such a device would discourage some people from using them in the first place. In its initial mode, Playful Utensils will simply activate tones and sequences harmoniously as opposed melodically to create interactive ambient music for cooking and dining, using the most natural and intuitive motions that these two activities are already synonymous with.

Concentrating on performing music that doesn't leave a bad taste in everyone's mouth can be a stressful task. Objectives such as playing in key, maintaining synchronicity, timing and so on can actually act adversely to having a pleasurable experience. Considering these problematic

outcomes, a central server in which the timing and key are always assisted in an advantageous way monitors each item in the Playful Utensils system. This is achieved by using harmony as the main vehicle to drive musical performance. Even if a member of the family does happen to play "out of step" or accidentally, dissonant notes can actually introduce interesting highlights within the composition. In this manner, "free-styling" and improvisation is actually promoted and rewarded.

Each pair of chopsticks acts as an instrument in an orchestra and is wirelessly connected to a server, much like an individual node in an ad-hoc network. Working in tandem, they create music. MAX-Stream Xbee modules complete the wireless network by broadcasting data to the server. Multiple pairs of chopsticks will stream data synchronously to the server. This enables collaboration in the creation of sound.

IV. QUALITATIVE USER STUDIES

To understand how to support communal behavior in dining situations, and find new opportunities for designing the system, three qualitative user studies were conducted before development our prototype.

The first two studies took into account cross-generational co-cooking scenarios using a computer-mediated environment through the Internet using the teleconferencing tool, i.e.: Skype. Shared activity, i.e.: co-cooking game and instructional co-cooking respectively was taken into account in order to ascertain the level of engagement when compared to cross-generational interaction using online tools without a pre-defined activity.

The third gestural study looked at how people eat together. Chopstick usage was analyzed and interpreted into a general family of gestures, which were then used to define the functions and actuations of the current prototype.

The first study implied hypothesis that a communal and synchronized activity supports communication shared between generations over long distances, engagement could be more lasting compared to telecommunication without shared activities.

The second study implied the hypothesis that learning would be more effective using enactive

cognitive theories when designing a computer-mediated interaction.

The third study confirmed the assumption that gestural data in using chopsticks are rich for extrapolation.

These studies informed our design for the current prototype of Playful Utensils. They were designed to enable new communication activities, encourage people to join in sound and music creation, and at the same time, encourage communal playing. This will enrich engagement between parties who reside at different locations through gestural behavior, but may not have the means to physically be present to share these experiences.

A. *Qualitative Study One: Cross-Generational Instructional Co-Cooking Game Between Grandmother and Grandchildren*

In the first study, grandmother will teach grandchildren how to assemble their sandwich using real food. The first study consisting of two scenarios was conducted between grandmother and grandchildren in order to test our first hypothesis; whether communal, synchronized and shared activity between generations over long distances could increase engagement duration and quality. As a comparison, both parties played face-to-face for fifteen minutes, and were then separated in the second scenario and continued to play over the Internet using a computer-mediated environment facilitated by Skype.



Figure 1. Grandmother instructing grandchildren over the Internet using Skype and real food

1) *Description of Participants*

We chose participants who has experience living apart from their close family members and are used to telecommunication. In this study, the chosen family crosses three generations, the grandmother in her 60's visiting from the USA; two kids – 5-year-old boy and 3-year-old girl. The family has multi-culture background, as father is from Spain and mother is American Hungarian.

It is assumed that each subject has some measure of experience playing with one other and that a socio-political framework involving each family member individually and in tandem has been established prior to this study.

2) *Observations and Learning*

According to observations from parents and grandmother, the children became more engaged with tele-presence communication through task-oriented play.

Communication between children and grandparents were more engaging, they both are strongly engaged with the game and shared the interactive narrative. This differs from the reflections of all parties when recounting conventional interaction previously shared using Skype without a shared activity.

There was some disparity between looking at a video stream and using objects. The girl tended to engage with the grandparent visually through video conferencing, while the boy tended to engage with the make-belief toys and followed audio cues from the grandmother as apposed to using video and visual cues.

People became more engaged with tele-presence communication through task-oriented play. “Small-talk” and “chit-chat” was eliminated, replaced by an interactive narrative shared between parties.

Using a playful interactive learning toy, instructional embodying tasks can assist play, which are normally communicated verbatim, using tangible objects instead.

Toys should assist instruction using multimodal feedback; therefore objects should embody multimodal communicative qualities such as haptic, sound and lights.

This could provide a seamless and engaging experience that moves focus away from mono-directional, instructional learning towards experiential and enactive methods of cognition.

B. Qualitative Study Two: Cross-Generational Instructional Co-Cooking Using Real Food Between Mother & Daughter via Skype

The second study was designed to test co-cooking activities via telecommunication channel. The aim of the daughter, who has basic cooking knowledge, wants to learn more sophisticated recipes from mother using a computer-mediated environment.

1) Description of Participants

In order to understand how computer-mediated environments affected established relationships, subjects with close relationships were chosen. The chosen subjects were mother aged 58 and daughter aged 26.

Mom lives in Shanghai while daughter lives in Singapore. Although there was no temporal distance, geographically, the distance was real, which added to the experience of the experiment subjects.

The mother had sophisticated skills in cooking, whereas the daughter was familiar with cooking simple dishes. Both mom and daughter have had some experience cooking together before but never through the Internet via a computer mediated environment. Both mom and daughter have had no formal cooking instruction training.

2) Observations and Learning

During the exercise, both experimenters noticed and participants reflected that communication was mostly to convey control timing and temperature, order of actions and amount of ingredients.

Both parties were mostly occupied by audio cueing and did not paying attention to the video

stream during the cooking phase. This could be because of the physical coordination needed in the cooking process, as well as the attention to things such as colour of food, taste while cooking, etc.

Participants naturally developed easy-to-follow expressions for measuring. For example “throw in three spoons of sugar; mix with one spoon of water; warm up the oil for three minutes; now is about right”, etc.

Both mom and daughter mentioned that they wish that the video camera was better placed, as opposed to physically attached to their display on the notebook computer, suggesting that current technology does not adequately support such types of interaction.

Follow up results reveal that daughter has built up confidence for learning more sophisticated recipes using this type of communication. She also expressed confidence in recreating the dish because she has the opportunity to cook together with her mom, albeit through use of the Internet and not face-to-face. Both parties also expressed that the experience was enjoyable and it was good to be engaged with an activity as an alternate means to spend time together using a computer-mediated environment over long distances.

These outcomes support the second hypothesis that learning could be enhanced using enactive and multi-modal activity, even when using a computer-mediated environment.

C. Qualitative User Study Three: Gestural Study Using Chopsticks

Finally, in order to understand how users would negotiate food with chopsticks specifically,



Figure 2. Mother and daughter co-cook using Skype on Internet



Figure 3. Video still of chopstick use gesture analysis

we conducted an observational study of groups of people eating food with the utensil. The observations we recorded and analysed in order to extrapolate specific gestures that were used with the utensil. These gestures were then mapped to specific actuations in our prototype that triggered sounds produced by our software server-side. Corresponding food attuned to the utensil was used, in this case Chinese food.

V. SYSTEM DESCRIPTION

Chopsticks embodied the first prototype of the playful utensils system. Chopsticks were chosen for its potentially rich and diverse set of gestures. It also addresses a cultural significance in regards to Asia in which the Playful Utensils system was developed for.

To make each utensil easy to use, only the power supply, gestural data acquisition module and wireless unit are located on the chopsticks.

The server side software sub-system running Cycling '74's Max/MSP is used to analyse gestural data and generate music. More details are introduced in the next section.

A. Hardware Design

The system electronics are divided into two main subsystems. Built from proven, off-the-shelf hardware, the system is very robust. The two main subsystems, which are the utensils and the server, are described below.

1) Utensils

As seen in Figure 4, this is the third iteration prototype, which is lightweight to achieve robust gestural capturing during use, reliable network performance and low power consumption.



Figure 4. The Playful Utensils prototype system

2) Sensing

After experimentation with different sensing methods such as photometers and linear potentiometers, accelerometer and compass sensing was finalized for the actuation translation of gestures. This decision provides a fluid and easy way for users to interact with the system without having to press a complex series of touch-points as found in a linear potentiometer, and is independent of ambient lighting as photometers often are.

The accelerometer and compass units are connected to a custom-made circuit. We use the Analogue Device ADXL345 3-way accelerometer for our current sensing needs. This provides us with a small, thin, low-powered unit with 13-bit resolution and tilt and dynamic acceleration sensing capabilities.

3) Networking

Also attached to the breadboard is an Xbee wireless module that uses the 802.15.4 protocol stack on the 2.4GHz wideband spectrum, providing the utensils with simple and reliable, low-power, wireless connectivity to the server.

4) Power Supply

A quick-charging, flat, compact and regulated, 3.7v, 110mAh lithium ion battery powers the entire utensil unit.

5) Server

To achieve real-time processing of signals, as human hearing could detect tiny time delays in sound feedback, all data processing is streamed onto a server. An off-the-shelf, late 2010 Macbook Pro computer provides enough

Playful Utensils

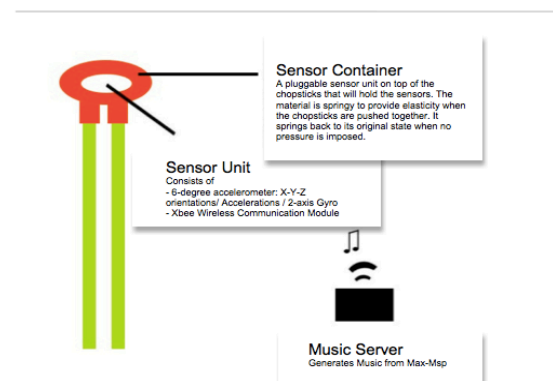
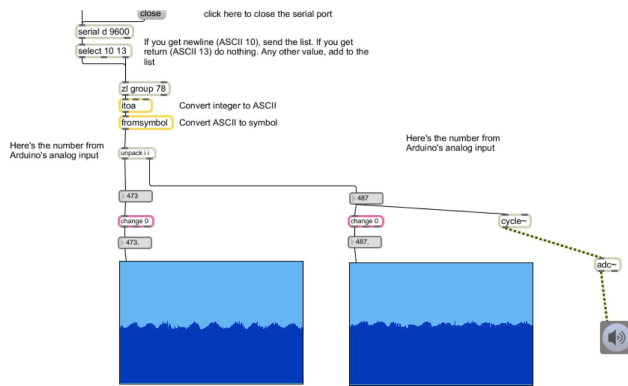


Figure 5. Diagram of the Initial Prototype



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Figure 6. Gestural data acquired from utensil-embedded accelerometer in Max/MSP

processing power for real-time performance, and is a reliable platform to run music generation programs.

The Playful Utensils system server runs Cycling '74's Max/MSP. The program coordinates the utensils, as well as plays audio according to the gestural information. All data is transferred wirelessly to an Xbee receiver attached to the server via USB.

B. Software Design

The software sub-system that controls the analysis of gestures and playback of appropriate audio was written in Cycling '74's Max/MSP. Max/MSP. It was chosen because it is a high-level, object-oriented programming environment designed for creative practitioners.

The visually oriented interface is relatively easy to use, is well supported by the software developers who publish it. It also has a strong community of end-users. For these reason it is an ideal development platform for other developers to appropriate and modify our system in order to promote widespread adoption for research purposes.

When food is prepared or eaten with the utensils, the gesture data is recorded by the accelerometer and is transported over serial connection using wireless network connectivity. This data is placed in a list and is decoded then filtered by the software, triggering audio in the pentatonic scale within a ± 2 -octave range. A digital-to-analogue converter built into the software platform interprets the data, which then

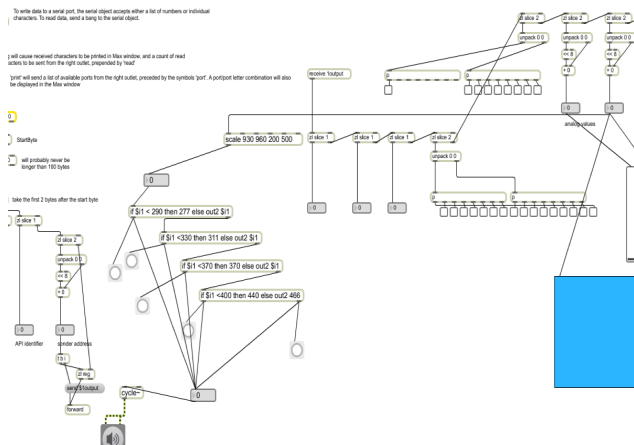


Figure 7. The Playful Utensils Cycling '74's Max/MSP patch

plays the appropriate frequency through output speakers.

VI. FUTURE WORK

We are currently looking into the technologies needed to achieve the most nurturing and intuitive user interaction possible for the Playful Utensils system. A prototype has been recently developed and once more affordances in relations to the above-mentioned studies are considered, researchers can further work with families to accurately design the user experience that is needed to express the objectives of the Playful Utensils system.

The initial prototype will also be shared with chefs in order to extrapolate an accurate way to generate sounds within the boundaries of use for each utensil that is explored. Game-like functionality will also be explored. Finally, composers and musicians will be consulted so that researchers can begin to create a new type of cooking and dining musical notation based on the Playful Utensils systems which will hopefully lead to the publication of a Playful Utensils song and recipe book.

VII. CONCLUSION

We presented a qualitative study regarding intergenerational co-cooking, instruction and leaning using a computer-mediated environment, which lead to the design and implementation of an activity based utensil.

We have learned that playful activity can improve the quality of engagement and communication.

Using these findings, we have developed an initial prototype, which we will use to further study shared, communal and collaborative activity in a co-cooking and co-dining environment using computer-mediated environments.

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