The Interactive Dining Table

Florian Echtler
University of Regensburg
Chair for Media Informatics
florian.echtler@ur.de

Raphael Wimmer
University of Regensburg
Chair for Media Informatics
raphael.wimmer@ur.de

Figure 1: Augmented meal on an interactive dining table

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Abstract

Large-scale interactive surfaces are nearly ubiquitous in research labs and showrooms around the world today. However, unlike other recent interaction technologies such as smartphones, they have not yet found their way into people's everyday lives. Possible reasons include high cost as well as a lack of suitable applications. In this paper, we present our prototypical implementation of a low-cost, unobtrusive interactive surface, integrated with the dining table in a real-world living room. To motivate our approach, we explore three scenarios highlighting potential applications for our system and present their prototypical implementations. In the first scenario, we extend regular board games with interactive components without sacrificing their unique haptic experience. In the second scenario, we investigate ambient notifications which provide a method for delivering information to the users subconsciously. Finally, we introduce and explore the concept of *augmented dining*, in which the appearance of food placed on the table is augmented or modified through the system.

Author Keywords

augmented reality, gaming, real-world setting, Kinect sensor, interactive table

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

General Terms
Design, Experimentation, Human Factors

Introduction
Large-scale interactive surfaces, such as interactive tables or whiteboards, are now a regular sight in research labs, showrooms or education-related settings. However, unlike other recent interactive technologies such as smartphones, they are still a long way from becoming a part of people's everyday lives.

This lack of adoption has several potential reasons. As an example, we will consider the Microsoft PixelSense (formerly Surface) [5]. First, the price of such a system is still prohibitively high - the 40 inch PixelSense display costs approximately US$ 9000, while a similarly sized regular flatscreen display costs less than 10% of that amount. Second, it is reasonable to expect that people do not want a dedicated interactive table in their homes, but would rather have the interactive features integrated into an existing table such as the dining table. Moreover, furniture are long-lived items which are replaced far less frequently than entertainment devices.
In this paper, we present and discuss an unobtrusive and low-cost system which is designed to address these issues. Our approach is to integrate the interactive components with the dining table in a real-world living room (see Figure 2). The system prototype is composed of a Kinect depth camera integrated into the table lamp for sensing interaction and a small LED-based projector mounted on the ceiling for displaying information on the table. The total cost of the system is approximately US$ 500 (excluding computer), placing it in the same price

Figure 2: Interactive dining table with augmented board game, integrated into real-world living room

category as game consoles or similar types of consumer electronics.

Of course, this leads to the question why people would actually be interested in having such a setup in their own living room. To motivate our creation of this system, we describe three scenarios which explore potential application areas.

First, we present our concept of augmented board games which merge the unique properties of physical game pieces with the computing capabilities provided by our system. We also present a concept of ambient notifications which can be used to convey everyday information, such as weather forecasts, to the users without requiring conscious attention. Finally, we introduce the concept of *augmented dining* in which the users' efforts to make more conscious and informed decisions about their food consumption are supported by the system through various visual augmentations.

Related Work

There seems to be little related work which attempts to merge large-scale interactive surfaces into people's everyday lives. Preliminary research in this direction has recently been conducted by Kirk et al. [2], in which the authors have placed several dedicated photo browsing tables in participants' homes. However, most current research still focuses on creating interactive experiences in public spaces. One recent example is the work by Marshall et al. [4] where a multitouch surface was placed in a tourist information center along with an application for planning day trips through a city. A defining criteria of this research is that it is geared towards brief interactions from people who are not assumed to be familiar with the system, as opposed to people interacting with appliances in their own homes.

With respect to board games, most related work focuses on adapting existing board games to interactive surfaces, not the other way round. For example, the *Settlers of Catan* [8] game we focus on has been implemented for the original Microsoft Surface [9] as a predominantly digital game. Chaboissier et al. [1] describe *RealTimeChess*, a game for digital tabletops that started as a straightforward implementation of regular chess and evolved into a touch-based four-player game that has little in common with its original inspiration. Earlier work by A. Wilson uses a short-throw projector to create a self-contained system, PlayAnywhere [10], which can be placed on arbitrary surfaces to enable augmented gaming.

In terms of sensing, the more recent work of Wilson [11] which describes the Kinect's sensing capabilities on everyday objects is central to our approach. It enables the use of arbitrary non-reflective surfaces as touch sensors, thereby greatly enhancing the options available for creating robust interaction spaces.

In a different approach to robustness, coverings such as Gorilla Glass[1] are regularly employed to make interactive surfaces, both large-scale (PixelSense) and small-scale (smartphones) more resistant to physical damage. Nevertheless, none of the currently available interactive surface technologies would probably be able to withstand prolonged use in a home setting, with the danger of accidents such as dropped glassware and fluid spills looming.

Hardware Setup

Our prototype can easily be installed in a common dining room. A diagram of the setup is shown in Figure 3. As mentioned above, the main components are a small LED projector on the ceiling (LG HS200G) and a Kinect for

[1] http://www.corninggorillaglass.com/

Xbox360 camera. As shown by Wilson [11], the Kinect's depth sensor can be used to sense touches and detect objects on arbitrary surfaces, a concept which allows using an unmodified dining table as the basis for our system. Consequently, the system also exhibits the same robustness to scratches, fluid spills etc. as a regular table.

The Kinect has been integrated into the ceiling lamp to avoid occlusion and to maximize the surface area available for interaction by adjusting the lamp height so that the Kinect's viewing cone covers the entire table surface. Moreover, the lamp provides a convenient "hiding place" for the Kinect and its cabling - people not familiar with the system tend not to notice the additional hardware. Device manufacturers could easily integrate the entire hardware into a single small and robust device which could be attached to existing lamps, perhaps even drawing power from a lamp socket similar to LuminAR [3].

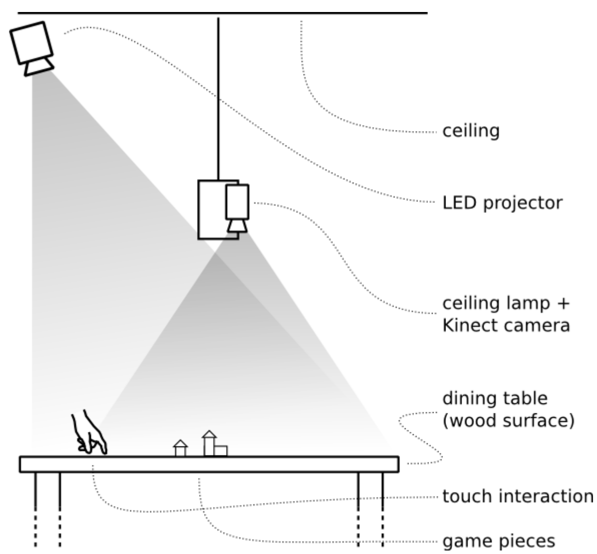

Figure 3: System hardware diagram

An additional advantage of having all active components mounted to the ceiling is that the required calibration only depends on the relative position of projector and Kinect camera plus the table's height, but not on the position of the table. Consequently, unintentionally moving the table will have no negative influence on the system's operation (with the obvious exception that if the table is moved too far, part of the projection will no longer be on the table surface). On the other hand, nudging the lamp will distort the calibration noticeably while the lamp is swinging; however, our experience shows that after the lamp has come to rest, it will be sufficiently close to its original position so that no recalibration is required.

Figure 4: Augmented *Settlers of Catan* board game. A player checks the success chances of a potential location for a game piece.

Augmented Board Games

As the first usage scenario for our setup, we have chosen *augmented board games*. An example of such a board game, the popular *Settlers of Catan* [8], is shown in Figure 2. In general, players of a board game can be expected to have little interest in an augmented version, since they are familiar with the rules and might also want to focus on a non-digital experience. However, there are some aspects where an augmented game can offer tangible benefits compared to an unaugmented variant.

In the *Settlers* game shown above, players roll two dice and receive resources from the game tiles labeled with the corresponding number if one of their game pieces has been placed on an adjacent intersection. In our setup, we have replaced the numbers indicating the required dice roll with projected labels. In the original game, these numbers are simple cardboard markers which do not offer any additional game value and have to be distributed manually before the game can start. Consequently, replacing them with virtual markers shortens the setup time required prior to playing without changing the game experience. Other side tasks such as tracking scores could also be automated, thereby lowering the players' cognitive load.

Many board games such as *Settlers* are designed to be "easy to learn, hard to master" - they are based on simple rules, which form complex relations over the course of the game. For example, it is difficult for novice players to estimate the success chances provided by a potential settlement location. Consequently, our augmentation aims to support inexperienced players in their decisions by displaying the total success chance of a particular location as a percentage when the location is touched (see also Figure 4).

Ambient Notifications

Users can be expected to spend at least some time at the dining table every day, usually at predictable times (e.g. for breakfast). Consequently, suitable information for the situation, such as weather forecasts or traffic information, could be displayed directly on the table without requiring any interaction from the users. By automatically showing a small set of relevant data in an unobtrusive manner, users can absorb this information without the need for conscious attention. As an example, a possible implementation for ambient weather notifications is shown in Figure 5. The icon and text rotate slowly to enable persons at all sides of the table to easily access the displayed information without conscious effort.

Figure 5: Ambient weather notifications

Augmented Dining

As our final scenario, we introduce the concept of *augmented dining*[2]. More and more people try to make conscious decisions about their food consumption by keeping informed about ingredients, calorie content and similar facts. Our interactive dining table is capable of supporting these goals by augmenting dishes placed on the table with projected information. Dishes can be tracked using the same methods outlined above, keeping the augmentations spatially aligned with the dish they refer to. An example of such an augmented meal is shown in Figure 1.

[2] A related variant which projects *virtual* food onto the plates before the real food is served and might consequently be called *augmented ordering* is used in the inamo restaurant in London (http://www.inamo-restaurant.com/pc/)

A different variant of augmented dining might also be called *augmented dieting*, comparable to previous work by Narumi et al. [6]. As shown in numerous studies such as [7], food color can influence the taste perception and consequently the amount of food consumed during a meal. Blue color in particular has been shown to markedly reduce food consumption. However, using blue lighting for the whole room may have unwanted side effects, such as influencing people's mood. We can use our augmented dining table to simply project a spot of blue light onto the dish, thereby subtly tricking people's perception of the food and lowering their food consumption without resorting to large-scale changes to the room's lighting.

Conclusion & Outlook

We have presented our concept of an interactive dining table which can be integrated with existing dining tables at reasonable cost. We have explored several variants of interactive augmentations which can be applied to tasks regularly carried out at such a table, e.g. board gaming or simply eating dinner. We plan to prototype and evaluate other types of augmented board games such as chess, look at additional classes of ambient information which could be displayed on an interactive dining table, e.g. train schedules, and conduct user studies regarding our newly introduced concept of *augmented dining*. Moreover, we plan to install this setup in other homes, thereby enabling us to receive additional feedback on our concept "from the wild".

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