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tANGibLE: a Smart Tangible Home Controller

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Abstract

Gadgets that are used in everyday life address a wide range of functionalities. At the same time we observe a trend toward more simple and natural user interfaces. In this paper we describe the shape-centered design process of tANGibLE, which resulted in a smart tangible home controller with easily accessible functions and a high degree of joy of use.

1 Introduction

Gadgets that are used in our everyday life such as household appliances, multimedia devices, or vehicles offer an expanding range of functionalities. At the same time, interaction with highly sophisticated devices is becoming more simple and natural. Therefore, the devices need to combine user inputs and information from various contexts in order to cater user expectations. tANGibLE was designed to meet these requirements by offering a simple, playful, and handy input device. In section 2 we describe the design process followed by the prototype creation described in section 3.

2 Concept

The conceptual process behind our work is based on an object-centered design process (cf. Brade et al. 2013, Groh et al. 2012). We started with an analysis to discover the properties and characteristics of a chosen object (see *Object analysis*, section 2.1). We thereby pursued the goal of creating a set of design variations, affordances, states, and state transitions before we started to analyze a given problem (see *Application scenario*, section 2.2). The results from both steps were finally combined in the third step (see *Fusion*, section 2.3).

2.1 Object analysis

The simple, geometrical shape chosen for the design process was a rectangular cuboid. Cuboids are dominated by an angular shape and have a solid and self-contained appearance. In the real world, box-shaped objects, like small bricks or large containers, suggest interaction techniques such as moving, rotating by 90 degrees, or stacking, depending on their weight and size. Based on these observations, we designed an angled interaction object with similar properties. It encourages the user to combine multiple objects and to create either symbolic or iconic compositions, which can be easily memorized (see Figure).

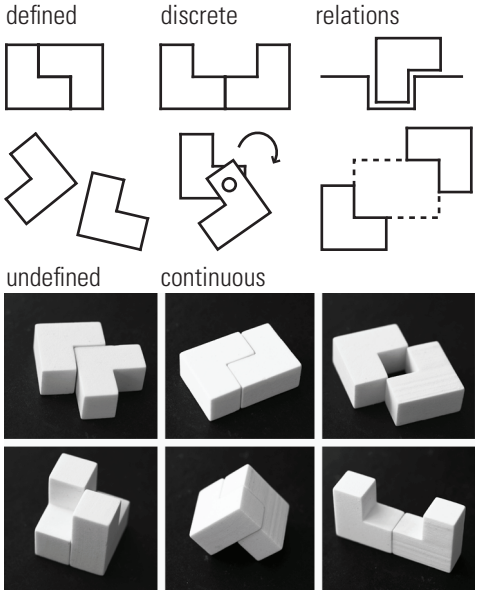

Figure 1: Prototypes of angled interaction objects: different states (left), iconic/symbolic compositions (right)

2.2 Application scenarios

The use case is a smart home with the need for a controller and monitor of the home automation system. To promote alternative solutions and new interaction techniques, we decided to avoid typical matrix-displays, buttons, and menus. Home automation systems cover a wide range of applications, such as lighting, security, entertainment, and heating or cooling systems. These functionalities can be controlled remotely or at home. The interaction objects are conveniently placed on flat horizontal surfaces, such as the living room table and thus lend themselves to an in-house scenario. The application scenarios were further refined during a Lego Serious Play workshop (Tröger & Jentsch 2012) and the use of a persona as interaction design tool.

2.3 Fusion

The last step of the design process consisted of combining the results from the previous two steps. We examined the following three exemplary scenarios: (1) bathtub, (2) home heating, and (3) alarm clock, which were mapped to a unique composition of the angled objects as described in section 2.1 (see Figure 2). In addition, we analyzed the data type, information, and the different states for each function implied by the application scenarios. The (1) bathtub has the operation states "empty", "emptying/filling", and "filled" which are represented by the LED light modes "off", "blinking", and "on", respectively. To trigger the functions "empty" or "fill" the user has to exert the pressure sensor (see section 3) and disassemble or assemble the corresponding composition, respectively. The same principle applies to the remaining scenarios. The (2) home heating has the two states "off" and "on". Temperature can be regarded as a continuous, quantitative value which was mapped to three different levels to simplify the use. To switch between the four resulting states (“off”, 1 to 3) the user has to rotate the sensor, as counterpart to the actor, by 90 degrees. The active state is represented by the current object composition and LED brightness. State transitions are furthermore indicated by a subtle vibration. The (3) alarm clock has the three states "off", "activated", and "ringing". It can be activated by placing it in an upright position, which is recognized by the motion sensor. When the alarm goes off, the LEDs start to blink. The alarm can be disabled by tipping over the clock.

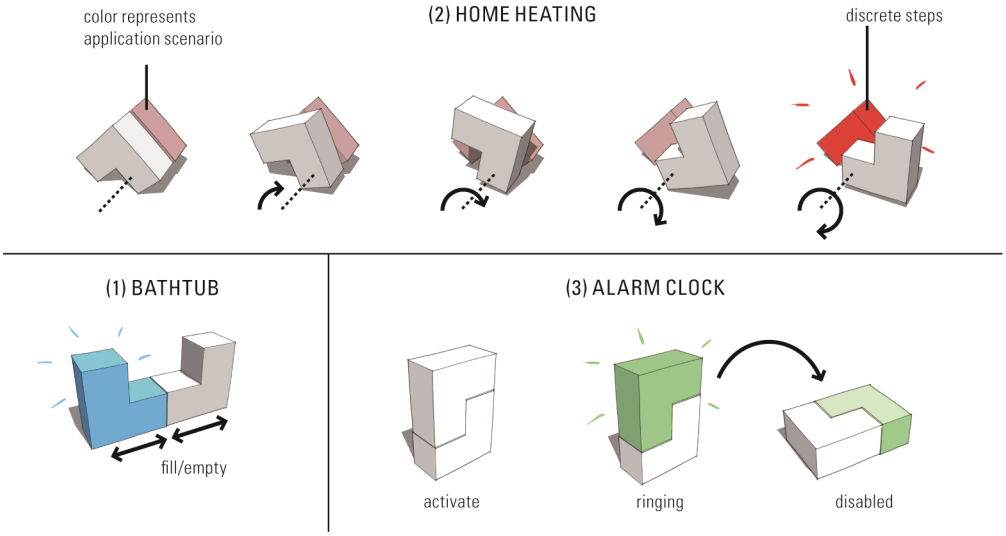

Figure 2: Sketch of the three application scenarios (1) bathtub [blue], (2) home heating [red], and (3) alarm clock [green] and the corresponding functions

3 Prototype

The prototype shown in Figure 3 is built of plastic and acrylic plates with magnetic bipolar contacts on the sides. An Arduino Nano microcontroller performs all logical operations.

Rotation and global position of the interaction objects is measured by a six axis motion sensor. The composition of two tANGibLEs can be identified by completing different circuits with the magnetic contacts. A pressure sensor measures the force the user exerts on the device. RGB LEDs and a vibration motor are used for feedback and to inform the user if an action was recognized or performed correctly. The prototype is not yet independent from power supply and serial port communication via USB. To test our prototype, we developed a virtual 3D environment with Unity which simulates the three application scenarios mentioned in section 2.3.

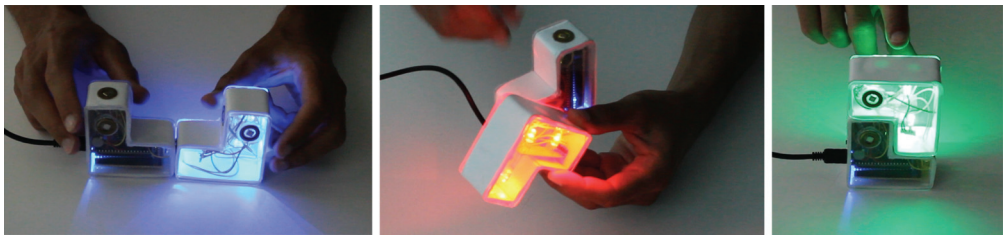

Figure 3: (1) Filling up the bathtub, (2) controlling the home heating, and (3) disabling the alarm clock

4 Conclusion

In this paper we described the conceptual design process of tANGibLE, a smart tangible home controller. By first analyzing an object and application scenario separately, we showed that this process has the potential for creating novel interaction techniques such as the use of compositions to control specific functionality. tANGibLE can be used to control additional functions, which can all be triggered without dipping into menus. Its simple and playful character invites interaction and increases the joy of use.

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