CUBER – CONTROLLING AMBIANCE IN SHARED APARTMENTS TO ENHANCE ACTIVITIES

CHRISTIAN CARLSSON
CHALMERS UNIVERSITY OF TECHNOLOGY
CHRCAR@STUDENT.CHALMERS.SE

HANNA FRANK
CHALMERS UNIVERSITY OF TECHNOLOGY
FRHANNA@STUDENT.CHALMERS.SE

ANDREAS KARLSSON
CHALMERS UNIVERSITY OF TECHNOLOGY
ANDKARM@STUDENT.CHALMERS.SE

MYLÈNE MENGUAL
CHALMERS UNIVERSITY OF TECHNOLOGY
MENGUAL@STUDENT.CHALMERS.SE

ABSTRACT

As the prices for housing increase, the question arises whether there is a way to build smaller apartments, yet keeping all the conveniences of a bigger apartment and making it possible to be shared by several people. The concept of Cuber seeks to provide a solution for the problem of having limited space in a shared apartment by enhancing the different activities of the people living in it. Furthermore, it should enable each resident to create their personal space where these activities can be performed. In this paper, a concept is described which makes residents feel in control of their apartment and provides a way to fully adapt the environment to their needs. As a result, a prototype of a tangible cube shaped remote control was implemented that could control lights and sound in a room-like setting and was presented in an exhibition.

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INTRODUCTION

The housing situation in Sweden today is facing the problem of increased square meter prices. According to a 2013 report for Finanspolitska rådet (Sørensen 2013) in Sweden the prices have more than doubled since 1990 and are now higher than ever before. Features and technologies are currently being investigated that could make those small apartments more attractive for customers. This includes smart solutions for storage and space saving furniture, like the OMA's De Rotterdam project (Quintal 2014). Furthermore, plenty of advice on how to make an apartment appear bigger can be found online, e.g. Bourne (2014). Tips range from adding mirrors, using light colors for the walls to having small distributed light sources. Those interior design focused ideas inspire to think about how ambiance, represented mainly by lights and colors, can influence people's perception of space, their feelings and behaviors. Areas in psychology deal with this effect of color on the mood and common sense often implies, for instance, blue as a productive color or green for tranquillity. On the other hand, the topic of smart homes (a home that adapts to the user's needs) is part of several researches. For instance, Ross and Keyson (2007), investigated controlling ambient systems and a way to make the interactions with these more tangible and integrative in the everyday context.

The project being described in this paper was realized in collaboration with the construction company PEAB. The constraints given by this client were to focus on an apartment with the size of 54 square meters and the fact that it should be shared by three to four people. This means several people living together in an area that is usually used by one or two people. The target group was defined to be families of four. Thus, problems like combining different incompatible needs and interests,

like playing loudly or relaxing, had to be considered thoroughly.

CONCEPT AND DESIGN

The Cuber concept deals with the above mentioned constraints of limited space in a shared apartment. It supports the inhabitants with performing their various activities, such as relaxing, working, playing and provides them with the possibility to create personal spaces by adapting the environment. The concept is divided into two parts, both based on the simple idea of a cube. Firstly, the layout of the apartment is flexible to be arranged for the different needs. Secondly, a way to control and adapt the environment including certain parameters such as light and sound is provided. The two components and the design decisions that were made will be discussed further in the following paragraphs.

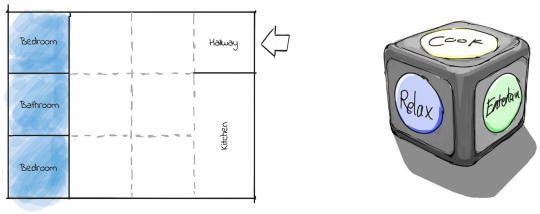

Figure 1: Cuber concept: (a) layout of the apartment, (b) the cube as a remote control

THE APARTMENT

First of all, the focus was set on the apartment and on rearranging it by defining specific areas, but without going into architectural detail.

As it is visualized in figure 1.a, the layout is divided into squares of 2.1 x 2.1 meters which makes it convenient to combine them to different sized rooms. Additionally, twelve of these cubes would add up to approximately 54 square meters which fulfils one of the constraints. They are clustered in two main categories: private and public spaces. The first zone comprehends the rooms where people need real privacy, such as in the bedroom or bathroom. The second one has a fixed part, which contains the hallway and the kitchen along with dining room, and a large open area that is not dedicated to any activity in particular. Instead, it serves for all different activities that people wish to perform in their apartment. With the focus on the latter, the following parameters were defined, based on literature as well as common sense, to be adaptable to the inhabitants needs:

Light: The illuminance level of the ceilings lights can be changed, since it is indeed unlikely that the same brightness will be used for a relaxing environment as for working. Furthermore, when watching TV, lower light will make it easier for the viewer to focus on what's shown on the TV, as well as it decreases the chance of reflections.

Ambient color: Different colors of lights stimulate different moods and feelings and therefore are useful to enhance activities. As investigated by Vandewalle et al. (2010), the color of ambient light influences emotion processing in the brain. For example, blue color increases stimuli in the voice area and the area that is important for memory processing.

Ambient sound: Sounds and music are often used to create a relaxed feeling, as motivation for working or for entertainment.

Devices: TVs and computers could be automatically turned on and off.

Curtains: If the ambiance doesn't create enough separation from the other spaces, curtains can be used to support this. Curtains, rather than solid walls made out of glass or wood, were chosen since they are flexible even if furniture is in the way. They also lower the light "nuisances" as well as sound to some extent. Our idea incorporates that curtains will be fixed along a grid shown as dashed lines in figure 1.a but can be moved slightly to make space for furniture. It should also be possible to add and remove the curtains if wanted.

THE CUBE

Cuber can be seen as a universal remote control and a tangible user interface for controlling elements in the home that were described in the previous section. Instead of controlling each element separately, Cuber does it all in one motion. Just as the apartment layout, this remote control is based on the basic shape of a cube.

As shown in figure 1.b, each side of the cube represents an activity and by placing the cube on a surface, the activity facing upwards will be activated. The parameters mentioned above will then adapt automatically according to the settings for that activity. It is important to note that the users themselves decide what settings should be included for each activity.

The cube also includes location tracking which makes it possible to only change the elements directly around you, no matter if it's at the kitchen table or on the couch. For instance, a working activity could be set on the couch, a relaxing activity could take place at the kitchen table or vice versa. These personal spaces can be created wherever the cube is.

In addition to selecting the activity, the user can control elements by interacting directly with the cube. The user starts by pressing the button on the active activity side and can then make modifications. If the user wants to save the modifications, he presses the button again and the settings will be saved. There are four basic interactions that were defined in the concept. Changing the volume of the background music is done by moving the cube vertically; up for increasing the volume and down for lowering like using a slider. This interaction is similar to the volume changing on computers. In order to skip a song in the current play list, the cube is tilted slightly to the left (previous song) or right (next song). Changing the entire play list is then done by moving the cube to the left or right. In both cases the directions

commonly represent back or forth in audio or video interfaces and are therefore appropriate to use. As for changing the color of the ambient light, the cube is turned some degrees to the left or right. The colors are virtually arranged like on a color wheel and will change directly as the cube is turned. All interactions were chosen to be intuitive and easy to learn, providing the user with direct feedback of what is being changed.

The first motivation to introduce the cube was the simplicity implied by a tangible approach. It seems convenient to have a tangible object because the already existing switches and buttons for controlling the elements in apartments are tangible. On the other hand, digital controls like apps on smartphones can be complex for certain target groups like children and elderly people who might not be used to this kind of technology. The absence of screens in the Cuber concept makes the object even less complex and at the same time more durable.

The cube shape itself brings along several advantages. Having six equal sides makes it easy to see which side is active, namely the one facing upwards. Furthermore, the cube is a basic and universal shape that is known across many cultures, so “the affordance of the device is known to every potential user” Terrenghi et al. (2006). Even more, Block et al. (2004) who investigated different shapes for remote controls, claim that the cube shape makes it is easy to handle, provides intuitive interactions and is convenient to be placed on tables and other horizontal surfaces. The number of sides was also appropriate when defining the activities as it covered the most important ones. Besides, the cube can be seen as a playful shape and could, for instance, be used like a dice making it fun and easy to pick an activity randomly by simply rolling it.

METHODS AND PROCESS

The project process that resulted in the above explained concept featured several important phases.

In the first phase, a brainstorming session about what makes a home smart set our aim on making it more comfortable for every person to live in a limited space. Further discussions and background studies in literature helped to refine the focus on the inhabitants and their needs. The possibility to accomplish different activities and at the same time a feeling of comfort were defined as essential aspects to consider and with this the surrounding atmosphere that has great influence on this.

Secondly, based on the mentioned considerations, the basic concept was defined. A list of activities performed at home was determined and divided into private and public ones, focusing on the latter. Sketching the various possible layouts of the apartment with regard to the given constraints changed our view on the apartment itself. It opened up the common perception of a fixed room dedicated to a specific activity towards a more public space that can host any activity. Another part of the concept definition was the parameters that would be appropriate to adapt in the environment.

This led to the question of how to control all parameters of the environment and made us realize its complexity. It made obvious that the need to create a simple remote control that would link the adaptable parameter with the activities and the apartment. Further, the cube shape was decided on quickly, also because of its references in literature, but defining the most suitable size required some tests within the group. For this purpose different sized foam prototypes were created. Afterwards, bodystorming with these low-fidelity prototypes was used in order to find out what would be the most intuitive interactions with the cube. Finally, prototypes were realised that could be presented as part of an exhibition. The users there would evaluate them and give valuable feedback for further work on this project.

RESULTS

PROTOTYPES

The final prototype consists of several different parts that visualize the concept. Firstly, a full scale model of a corner of an apartment containing a simplified prototype of the cube. As support for explaining the concept a miniature model shows the layout of the whole apartment including the curtains which help to divide the open space. Lastly, a conceptual video shown on a screen next to the prototypes gives details about the interactions with the cube. The prototypes were presented in an open exhibition visited by students, architects and people from the industry.

Figure 2: Prototypes: (a) full-scale model, (b) cube

The corner of the apartment focuses on the aspect of controlling the ambience. It visualizes how the different environments could be created with the help of lights, music and curtains (see figure 2.a). The ambient light is achieved with the help of LED strips, in which each LED is addressable and whose color can be controlled individually. Two dimmable halogen lamps are mounted on the ceiling to demonstrate the different levels of brightness. Finally, speakers were installed to add various kinds of ambient music. The prototype of the cube, as shown in figure 2.b, consists of a 3D printed shell which contains all necessary electronic parts. A light-dependent resistor (LDR) on each side of the cube detects the level of light it is exposed to. If there is no light, it means the respective side is facing the table and the side opposite to it is facing upwards, which activates this. Additionally, a white LED on every side gives the user visual feedback of which side is active. All

parameters are connected to an Arduino microcontroller, which then detects what activity is on and activates the according settings for the lights. Furthermore a program running on a laptop plays related music from different play lists which are dedicated to the six activities. This prototype only shows the interactions of activating an activity; the manual control of the different elements was not implemented.

FEEDBACK FROM THE EXHIBITION

During the exhibition people were able to test the prototype and get an idea of the concept. In general, the reactions were positive, many were enthusiastic and confirmed that they would use a remote control like this at home regardless of the size of their apartment. Most people focused on the simplicity of the controlling rather than the manipulations in the apartment itself. Visitors had different opinions about the size chosen for the prototype, possibly also depending on the size of their hands. Some would rather use it stationary and therefore prefer a bigger size, others would like to carry around and play with it, which would make a smaller cube more convenient. Finally, the visitors' feedback included suggestions of applying the concept to other living space such as bigger apartments, offices, but also public areas like airports and train stations and even vehicles.

DISCUSSION AND FUTURE WORK

Despite the positive feedback, there are indeed some critical aspects that have to be considered for further work. As an example, using curtains to divide space is not ideal. The solution for now is easy to adapt and flexible, yet, it is not soundproof enough. Therefore, other material might have to be investigated in order to allow noisy and silence activities to be performed in parallel.

Cuber is aimed to be personal. This can create some other conflict cases, for instance, when two people try to activate their settings at the same place simultaneously. For now, one solution has been discussed but not developed any further. The idea is to prioritize the first cube activated in the concerned area. Then, if people agree on combining their preferences, it should be possible to let the system know by making the cube touch each other. Communication between the inhabitants would still be the key to solve conflicts.

Regarding the shape and size of the remote control some further user study would have to be conducted. One option could be adapting the size to each individual's need making it even more personal. Although the cube seemed to be an appropriate shape for its purpose, rounded edges to make it more ergonomic or even a different shape could be considered.

Besides, since the cube lacks affordances possible interactions might not be obvious which makes it less intuitive for first-time users. Providing the user with more feedback, for instance, when changing the elements with the cube, could be one focus for improving this. This could include haptic feedback in form of slight vibration of the cube itself. In that way, the user would not even have to look at the cube when controlling. Looking closer at the controlling part could also imply introducing more elements to be controlled by the cube such as radiators, ventilation and more electronic devices. Lastly the concept is adapted to a small apartment but could be applied to other kinds environments, as also mentioned in the user feedback.

CONCLUSION

Although our physical prototype did not support all interactions that were part of the concept, the video helped in communicating all the intended functionalities. In addition, the feedback we received showed that the concept addresses and interests all kinds of people. Controlling multiple devices in a home through a centralized controller is not a novelty. Yet, most existing ideas tend to involve a common remote control, an app or something similar as a control method - using a tangible device with such a simple interface is a new idea which is worth being explored further. The concept itself needs to be enhanced before it could be used for a finished product, whereby one important issue is the communication between several cubes and the control of the parameters before and while using the cube.

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