An IoT design exploration within the Rich Interaction framework

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ABSTRACT
Rich interaction in a growing system offers a huge impact on the development of interactive products. This paper documents four iterations of a light control device. In each iteration, the rich interaction was discussed through the description of the concept, feedbacks were received and was then incorporated in the next iteration. The goal of this device is to offer an alternative reality of a light control interactive product and explores the growth potential of the IoT system by adding several core functionalities.

INTRODUCTION
The development of the IoT system has injected more connected elements into people's lives, making their lives more convenient. At the same time, the design methods for IoT system are also developing and expanding.
A crucial feature of the IoT system is that it is inherently open, contains a huge possibility for developing and growing. The design of artifacts in an IoT system is not solely performed by the designers, but often exists as a co-creation process in which users play an important role. The subjective initiative of the user is vital for exploring the emergent functionality between the core functionalities of IoT artifacts in a growing system. In actual use, in addition to the designer's pre-designed core functionality of the artifacts, users are also likely to explore opportunities in their specific situation. This fosters customized emergent functionalities based on the connection between the core functionalities.
This inherent open and growing trait of the IoT system allows diverse design perspectives and methods to thrive, which may lead to different interactions and form in the resulting design. IoT products often require a digital interface, yet their interaction doesn't have to be confined to intangible interactions, IoT artifacts can also be integrated into rich interactions.
In the previous exploring study conducted by Joep Frens, the approaches of designing for embodied and rich interaction in growing IoT systems were explored. Four approaches were concluded, namely hybrid, modular, shape changing and service (Frens, 2017). Different design approaches may result in different product forms and different interaction possibilities consequently.
This paper presents a developmental process for designing a device with rich interaction in a growing IoT system. This device initially focused on lighting control in home IoT system as the first core functionality and the entry point gradually integrated the second core functionality, which was power (energy) in a home system, and further explored the growing possibility of adding more core functionalities.
Throughout the entire design process, the design went through four iterations. This paper records the corresponding introduction of each iteration, reflecting on whether each iteration meets the "rich interaction" criteria and whether it can truly adapt to the growing possibilities of an IoT system.
During the iteration process, the modular approach was the main guiding principle, but in the process of product improvement, other approaches were also involved, which shows that the correlation between these approaches is very natural, they can complement each other. Together, they yield more natural and richer interaction as well as more product functions.

RELATED WORK

Philips Hue Tap switch

*figure 1. Philips Hue Tap switch(*www2.meethue.com*)*

Hue tap is a wireless home IoT product to control Hue lights anywhere in the home at the touch of a button. Users can preset 4 different settings in this tap switch and can recall their favorite scenes easily (Philips. n.d.). It is an example of making lights into groups and creating lighting scenes at home. It could be seen as an embryonic form of a growing system. In this case, IoT devices are limited to lighting devices. The form element in this product was poorly designed, which is three similarly shaped buttons, this could cause confusions and frustrations to the users.

Orbit

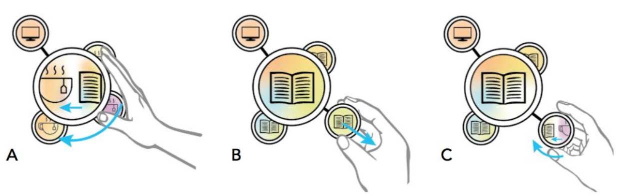

*figure 2. Interaction with Orbit. (A) By turning the selection ring on the global display, people can scroll through the presets that are uploaded to Orbit. Pressing the ring activates the preset in all connected areas. (B) By pulling an area display away from the global interface, the area does not respond to global lighting adjustments anymore. (C) Separate areas can be set to a different preset. (*Niemantsverdriet*, 2018)*

Orbit is a tangible light interface for the living room and it is a design case in Niemantsverdriet's Ph.D. thesis (Niemantsverdriet, 2018). *"The interface is wall mounted and consists of a global display that can be used to select global lighting presets, and smaller local area displays that can be used to select lighting presets that are only applied to lamps in a specific area in the room (e.g., the lounge area, open kitchen, study area, or play corner)."* This design case was designed to create awareness in the home environment while it is a decent example of showing the unity of form, interaction, and function. Moreover, design challenge in this course, Orbit also show its growth potential as it has some characteristics of modularity. The main insufficient of this design case in the context of this course is that it also depends heavily on screens as its carriers of interactive input and output.

IoT Sandbox

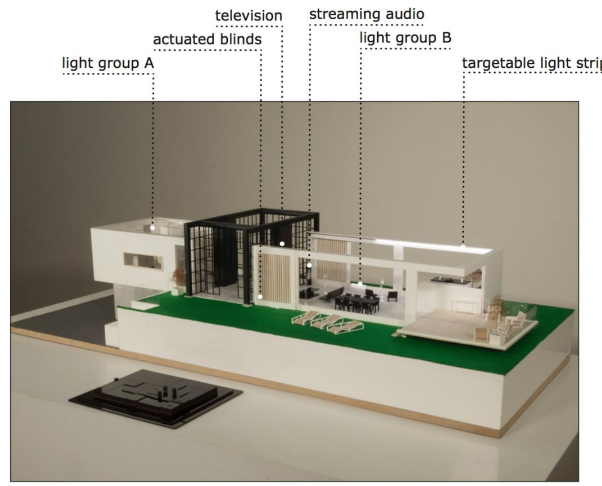

figure 3. The growing interface of the IoT sandbox

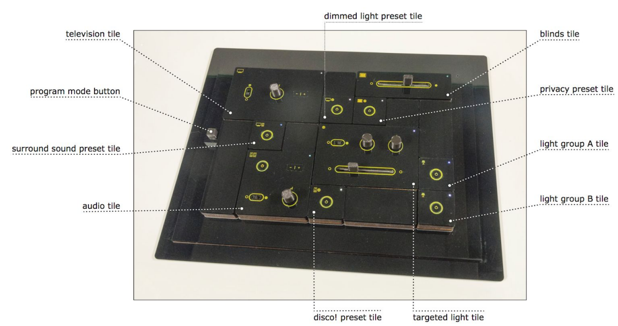

figure 4. The growing interface of the IoT sandbox

The IoT sandbox is a physically rich interface for a smart home and it serves as a part of a multi-year research-through-design project focused to generate knowledge on how to design for growing systems with high complexity and rich, potentially distributed interfaces (Frens et al., 2018). Unlike aforementioned works, it integrated the modular approach (Frens, 2017) to offer a rich physical interface for users to control not only the light groups but all kinds of smart devices in a home context. It brought useful insights for designers to explore the core functionality and the emergent functionality.

This case has something in common with the Orbit, they are both interfaces, thus, while the IoT sandbox explores the possible way to connect all kinds of home IoT devices and design for a growing scenario, it still is an "interface" which could not make full use of human skills. Another thing about this case is that the "home" was designed first, then the physical interface. In real-life scenarios, it is impossible for smart devices and systems to grow in this perfect way.

Iteration I

The first iteration of the design mainly served as an initial exploration of form and function. A physical sketch was made to accommodate discussion (figure 5).

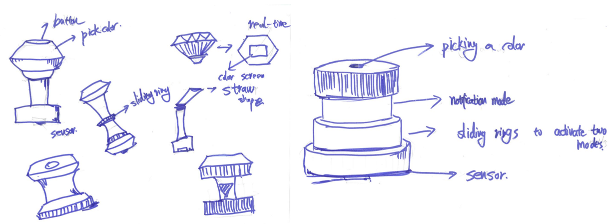

figure 5. Early concept sketches

The start point of this design should respect people's skills: perceptual, motor, emotional and cognitive (Overbeek et al, 1999). The aim of this design is to explore alternative realities where a digital screen is not the main input or output. In addition, the device needs to provide meaningful interactions when it is connected.

The concept should apply the framework of 'rich interaction' that Joep Frens (Frens, 2006) coined in his graduation paper: "an interaction paradigm that starts from human skills and aims for aesthetic interaction through the integration of form, interaction, and function".

Description

First of all, the form of the devices needs to be flexible and adaptive. Therefore the concept has a symmetric form that fits the size of the human hands.

The main functionality of this concept is "color picking": the Philips HUE was integrated into this device, users could pick a color from the physical environment. A sensor could be embedded in the bottom to sense the color, meanwhile, the HUE light would change its color accordingly. When a preferred color was 'picked', the user could press the button on the upper wheel to ensure that the HUE light stays the preferred color. Users could also adjust brightness by rotating the upper wheel, the intention of using this means of interaction was to offer users a good user experience because it was designed by obeying the rule of respect human's skills (Overbeek et al, 1999).

figure 6. Upright position

The concept featured an email notifier. It could be activated by flipping the device over. The form of the device changes which as below picture shows (figure 7). The middle ring slides to the other side, and the red part indicates that the email notification mode is activated. When an email was sent to users, the HUE light will change its color to red as well as its behaviors from a static light to a flashing one. This flashing light only lasts a few seconds to avoid annoying caused by this function.

figure 7. Flip over

Discussion

This device aims to offer tangible interactions (Ishii and Ullmer, 1997). It can be considered as a home light control device. Users could create multiple forms of action possibilities (Djajadiningrat et al., 2004). For instance, flipping, rotating. This device brings together form and interaction. Users access functions by changing the orientation of the device, which in turn altered its appearance through mechanical means.

The first iteration of this device focussed on limited aspects of functionalities (one dimension). Which were picking colors from the real environment, changing colors and brightness of the HUE light; sending notifications to the user when new emails were received. There were still plenty opportunities for improvements. For instance, adding multiple lights to indicate more scenes instead of controlling only one HUE light.

The hourglass was created as a metaphor by the group in this concept to indicate the flippable character of the device, however, comments were received that the introduction of the metaphor did not help to clear the usage of the device and led to some confusions to the users, for example, the misunderstanding about the identical functions on both sides .

Iteration II

The second iteration incorporated the critiques received on the first design, the main one being the one dimensional nature of the connection.

Description

The main challenge in making the second iteration was finding a meaningful way to use the device's connection to the rest of the world. This meaningful connection was sought by linking the device to online services.

A second wheel was added to the device to serve as a selector when the device was flipped over. The sliding ring which in iteration one merely served to obscure a colored portion of the device now covered the selection window in the upright position (figure 8).

figure 8. Upright position

figure 9. Flip over to reveal selection window

By turning the selection wheel different icons would appear in the selection window (figure 9).

figure 10. Four modes to choose

Besides options that used some internet connected feature, presets were added to improve functionality. The selectable options were: Reading mode, Party mode, Notification mode, and Weather forecast mode (figure 10).

Reading mode served to provide the user with a preset which would change relevant lights to a setting which could accommodate reading. The user has to predefine which lights needed to change to what setting, This could be done by using an app.

Party mode would use sound data, either received through an inbuilt microphone or a connection with a music streaming app, to change the lights in the room rhythmically.

Notification mode could be configured by the user to notify them of incoming messages or other alerts by briefly fluctuating the brightness of the lights. Which notification the lights responded to needed to be set up in an app.

Weather forecast mode would provide the user with the weather forecast in the near future. The forecast would be displayed by changing the color and behavior of the lights.

e.g. bright lights for sunny weather, blue lights for showers and, blue lights with white flashes for a thunderstorm.

Usage scenario can be found in the storyboard of this iteration in appendix A.

Discussion

The second iteration sparked some discussion on the meaning of the "meaningful connection". This group, as well as other individuals attending the course, inferred that the designs needed to have a connection with internet services and needed to use or upload data to "the cloud". It was made clear that an internet connection isn't necessary to make an IoT device and that the term served to convey the concept of multiple devices communicating with each other.

A discrepancy was noted between our interaction elements and their function. The wheels for changing brightness and for selecting a different function were identical, thus creating confusion in the link between form and function. A clear difference in appearance needs to be present in interface elements that serve such different purposes.

The second iteration provided users with some customizability in terms of the presets. The lack of screens or dedicated inputs were thought to make this an arduous task if done with the device itself. Therefore a decision was made to use an app to configure these functions. Feedback was provided that promoted incorporating these function into the device itself through more tactile means. It was also made clear that screens don't necessarily stand in the way of designing a rich interaction if done correctly.

Another comment was made about the lighting system as a whole. The environment the device was designed to be used in had to be designed itself to make a coherent system. The device that was designed covered the interaction and form parts of rich interaction, but the connection between the form and the function was very vague.

Iteration III

The third iteration incorporates "power" as a new functionality in addition to the original "light" functionality. In this iteration, the power function cannot be controlled directly but only served as an indicator of the power consumption. Adjusting the lights remains the responsibility of the user. This was a conscious decision based on the idea that a system should not take control away from users. This iteration also explored the relation between "distributed" & "centralized" in controlling home lights. Users would have the customizability to define their own light groups and to control them together or separately.

Description

In this iteration, the different function modes of lights in previous iterations were modified into lights groups which users can customize and select to control. Users could group any lights in their home to define certain areas as they wanted and made them a certain light group (see appendix B).

The functions of picking colors and change brightness were retained in this iteration. The upper wheel was the overall control (figure 11) of all the lights in the house. While being flipped over, the sliding ring would drop down and reveal the light groups for selection (figure 12), by rotating the sliding ring in the middle, users could then select certain light groups to control together (figure 13).

figure 11. The upper wheel is the overall control

figure 12. Flip over for separate control of different lighting groups

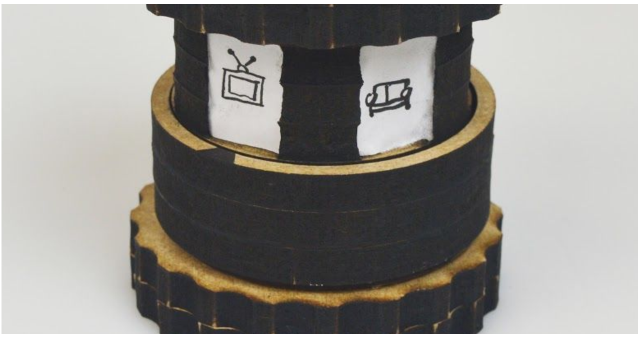

figure 13. Rotate the slide ring to choose lighting groups

The concept of “being aware of the power consumption of home devices” was brought in this iteration. The device was connected to the solar panels system in the house, showing the balance of power generation and consumption.

The balance was shown by the growth and color change of the central cylinder of the device (figure 14). When the energy generated by solar panels was more the energy consumed, the cylinder would grow higher and display green color. When the situation reversed, the cylinder would grow shorter and display red color.

figure 14. Height change indicating energy balance

In this way, users could have the awareness of their overall power balance, foster environmental conscious then change their behaviors accordingly. For example, if by the end of the day the device shows there was still plenty of energy left, this might give a positive signal to users that they could perform some extra activities which were energy consuming. On the contrary, if the power balancer showed red color, this indicated that users might have to reduce their power usage.

Discussion

The two core functionalities the third iteration addressed were light and power, yet the emergent functionality mainly lied on users’ subjective initiatives to control the power consumption level in the house based on their awareness raised by the power indicator in the device. However, users cannot control power directly through the device, this not only caused lots of inconvenience in operation level but also limited the growth possibility of the device to some extent.

In addition, the control elements in this iteration were not expressive enough. The button on the top of the cap was for confirming the color users choose, and the two wheels at the ends were for changing the brightness of the lights. However, the action the button invites - press - seemed to be not expressive enough for the picking color interaction.

When considering the growing possibility of the device and adding other functionalities to it, whether the form of the control element is expressive enough for its control parameters should definitely be taken into consideration.

the Final Iteration

Introduction

The final iteration was the integration of all the design requirements and improvements that mentioned above. It was also served as a foray into “system design” by incorporating one more mode to show the growth potential of the design. The original design was finally transformed from a single device into a system(set).

figure 15. Final iteration prototypes

Description

In this final iteration, a set of home control devices: a main device with three different caps were presented with a charging tray (figure 15). It was a set which designed to be placed on the table in the living room. The core value of this product was customized group control and the basic form of control was on/off. Three different primary function groups (control modes) were defined and rich interactions for each mode were developed based on their characteristics.

Different caps were designed to represent control over different modes. Switching between different modes was done by literally replacing the cap on the one side of the main device. The main device retained the function to display the current total power consumption of all the electrical equipments in the house through its shape under all modes since this group already envisioned that electricity would be the main form of household power consumption in the future in previous iterations. When the current total power consumption was high, the core column would rise up and display red, and it would display green in the opposite case. The middle ring still served as a selection tool for choosing customized groups under any mode as it was in previous iterations, the difference is that it is a screen now to support the convenience of showing different groups under different modes. More detailed information about all the functions can be found in appendix C.

- Light control mode

The form of the light mode cap remained the same as before. The simple shape promised that the device could be flipped over and had the same interaction style on both sides. Under this mode, the user could combine any lights to control their brightness or color together, and could easily control all the lights in the house by flipping it over. Changing color was done by using the main device as a color picker on both sides on any surface and users would press the screen-button on both sides to confirm their choices (figure 16 left).

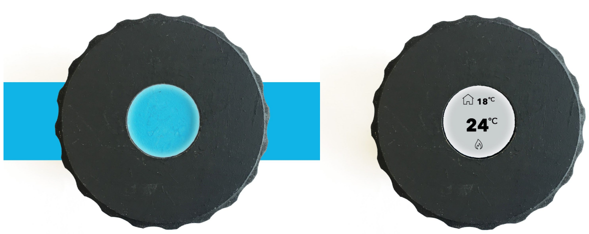

figure 16. Display of the screen on the upper wheel under light control mode and climate control mode

- Power control mode

The form of the power control cap was an imitation of the traditional switch element in circuits. The interaction and the function of this cap were also in line with the form because under this mode, users could only turn on/off devices. However, devices could also be grouped in order to be controlled together. The switch-shaped cap also indicated that the main device cannot be flipped over since it wouldn't support the device standing on the table in another position.

- Climate control mode

The form of the climate control cap was an imitation of a fan. Under this mode, the user could adjust the temperature of the whole house (figure 16 right) or adjust the fan speed of a specific area by flipping it over. This mode was an example to demonstrate that the design has the potential for growth, and users could add more functional groups according to their needs.

Discussion

A new functionality was incorporated into the design in the third iteration while the device still kept its basic form. However, in order to continue growing the design, modular approach - one of the four "approaches to growth" (Frens, 2017), was adopted in the final iteration. Modular approach composes controls for different functions to grow together with the system by creating inter-connectable interactive modules, each offering dedicated rich interaction(Frens, 2017). Instead of changing the whole device into a part of the modular system, the group chose to retain the main structure of the previous device and only the cap on the one side (the underside wheel) was redesigned to be modular. The idea is to make the full use of the original forms and interactions as much as possible while improving the expandability of the device to possibly add more customized modes.

In previous iterations, comments had shown some concerns about the expressiveness of the control elements. While adopting the modular approach to further develop the design concept, the control elements were also optimized according to the functional characteristics. In addition to the light control mode cap, the "fan" and the "switch" symbols were used to indicate the parameters of changing the wind speed and the state of the power supply. This was a decision takes into account the balance between the expressiveness and the ease of operation of the control parameters. As an exploratory home IoT device, the team argued that expressiveness achievements should not come at the expense of the ease of use. It is acceptable if the introduction of the suitable symbols ensures the balance between those two. One of the most discussed aspects of this design was the fact that the caps on both sides of the device are identical under light control mode. Previous feedbacks already showed strong concerns about the confusion brought by the identical form of the caps while they are actually in different levels of control over the lights. One of the possible solutions is to make the light control cap to be partially translucent, however, such adjustment still fails to reflect the hierarchical relationship between them. And the difficulty of this challenge is one of the reasons why an alternative design have not been proposed.

In this iteration, the emergent phenomenon occurs when the user switches between different modes and controls other connected devices. After many attempts, users would gradually understand and become more aware of their power consumption behaviors, and subjective initiative still plays a considerable role in this emergent phenomena. The possibility of multi-user operation and its social impact are now enhanced by the fact that it is no longer an integral device. One possibility is that the user can remove one of the cap to prevent other family members from adjusting certain settings. At the same time, the arrangement of the device on the table in the living room make the act of adjusting settings visible, thus, raise users' awareness and make them have a sense of responsibility for their own adjustments (Erickson and Kellogg, 2000).

System Design

The lighting plan in a house is very specific to the needs and taste of the occupants. Designing a specific lighting setup or even a special fixture would therefore limit the number of potential users. Smart bulbs offer the most flexibility while still offering a myriad of customization possibilities. This, together with the user settable groups makes for a universal lighting system. The power control aspect of the device relies on the ability to turn on and off electronic devices. This can be accomplished by using smart devices to which the control device can directly connect or by installing switchable power sockets that plug in between a device and an outlet. Heating systems with network connectivity already exist and could easily be controlled with the control device.

The overlapping feature of the control device described in this paper is the power use indicator. The device changes size according to the total power consumption of the household. The power use indication is visible regardless of the function cap that is installed. The device does not automatically alter settings based on the total power consumption but relies on the user to make these changes. The power indicator will show the power draw in real time and can therefore provide the user with immediate feedback when altering settings. Knowledge of what devices consume the most power will help the user reduce their power consumption and thus lower their impact on the environment.

New IoT systems often incorporate smart devices into their design. Smart devices are usually very personal and therefore anonymize the alteration of settings. For instance, if a house is equipped with Philips Hue bulbs, anyone who is connected to the Hue network can alter the settings without anyone knowing who it is. The device described in this paper is a physical centralized representation of the controls. To use it people have to walk up to it and physically change its appearance or orientation. These actions make it more visible to others in the room who is changing the settings of a specific function. The knowledge of who changed the settings allow for direct interaction with the person and might lead to a compromise in settings that more people agree with.

To adjust a certain setting the correct "cap" needs to be installed on the device. This not only provides a clear physical representation of the function, but also allows people to "game" the system. If for instance, someone is working on an important project that requires a certain light setting, they may take the lighting cap with them so others can't make changes without asking first.

Both raising attention for energy use, and the added social dynamics the device allows for, honor some of the complex principles raised in Frens and Overbeeke's paper on growing systems (Frens and Overbeek, 2009).

Growth

A modular approach (Frens, 2017) was used in the ideation of the last iteration. In this iteration, a series of interactive caps were designed and embedded with different sets of functionalities. By replacing different caps on the top of the main body of this device, this allows users to access different core functionality (eg. such as light control or climate control) and emergent functionality.

The core value of this device is group control, which means that users could add a lot of components into the dedicated groups, but still have the control over all the functionalities of the home devices.

Parameters of Use

The "parameters of use" framework was introduced in the course to provide inspiration on how to design a rich interaction style and open the functionality (both core and emergent) of the device. The control element is a physical element which can give users control over certain functions while it does not require to be practically meaningful. However, the rich interaction framework requires the form(of the control element) to reveal the function and indicate the interaction style at the same time. The group uses another way to translate this as a control element could be transformed into a parameter of use when it can be directly related to its functions and interactions.

The parameter is a notion for the variable in many other areas, which is always linked to and get influenced by all the other variables. This relevance and the mutual effect it has suggest that they are a unity. Such an idea could be used in the field of design for a growing system to remind the designer to pay attention to the relationships between all the functions where core functionalities should have the ability to be intertwined to create the possibility for emergent functionalities.

Centralized vs Distributed

Lighting and power in a home environment have traditionally been distributed. Lights are controlled by either switches on the wall or by switches on lighting fixtures themselves. Power in the form of electricity is controlled on devices separately. Only relatively recently have switchable power outlets, smart bulbs and other domotics started to centralize individual functions, often still keeping separations between distinct functions (e.g. one system for all the lights and a separate system for switchable outlets). Heating is generally more centralized (e.g. temperature is usually set centrally) but also incorporates distributed elements such as ventilation. The device designed in this project attempts to consolidate these functions into one centralized device. The centralization of the functions in key in allowing the user to monitor and adjust the power usage as all of these elements contribute to the total power consumption.

The device was designed to be room specific. Multiple devices can be used in a single household. Since the groups are user configurable overlap in groups and even control devices is possible. For instance, all the lights in the living room might be a group that a device which is stationed in the bedroom can control, this allows the user to turn off all the light in the living room before going to bed.

The approach that was chosen is not purely centralized or distributed, but more akin to a hub system in which multiple overlapping hubs may exist.

DISCUSSION

In this design process, how to design a growing IoT system from the perspective of rich interaction is the main concern. While tough challenges were encountered during the process, deeper understanding and reflection about how rich interaction play roles in a growing IoT system are also gained.

As the IoT system grows, new features and devices are continually added. The form of the control elements should be in line with the parameter of use it controls, which will then lead to more intuitive and richer interaction. In the pursuit of the rich interactions, the physical form of the product should meet the following characteristics: 1) respect and make full use of human skills physically, allowing users to fully explore the tangible interactive experience brought by rich physical details; 2) indicate action possibility (Djajadiningrat et al., 2004), allowing users to intuitively understand how to operate, what kind of actions to interact with the product; 3) the control elements should be expressive of their functionalities, control elements serve different functionality should be distinguished from each other in shape, and the form also has a natural connection with the parameter of use it controls.

However, for a unified IoT system, in the process of growing and gradually adding products that control more functionalities, a unity of form, interaction and function should still be retained. This uniformity allows users to understand the "rich connections" that exist between these IoT devices more naturally, so they can make better use of these connectedness and explore emergent functionality.

In the design process presented in this paper, the first concern is to incorporate the rich action possibility into its physical form. We are incorporating different detail functions on a device, but at the same time we have to consider whether the interaction caused by the control element is expressive. A challenge the team encountered was trying to retain the expressiveness of each control element while having to integrate these diverse elements into a physical device with limited form. Simply emphasizing the distinguishable expressiveness between the different control elements may lead the device to grow to be too complicated for users to use conveniently, yet form in unity might confuse users of the functions of each control element to some extent. In order to solve this problem better, more design approaches such as hybrid and service were integrated into the device, for example, some buttons on the top of the wheel were improved to be small round screens digital display still serve the action possibility of physical pressing (hybrid approach). In this way, the possibility of achieving expressive from various perspectives on a limited form carrier had been broadened.

Similar challenges were encountered when considering the “growing potential” of the device in IoT system. Different expressive control elements are required for different core functionalities, but these control elements need to have a certain degree of uniformity to indicating the internal connections of the entire system. The team chose to retain the major part of the device and replace upper caps to switch to controls of different core functionalities. Each cap is customized according to the function it controls, to ensure the expressiveness of form, at the same time, the retention of the main part allows the user to naturally feel the unity within the system. This can be considered a service approach.

This service approaches also offers great opportunities for adding new core functionalities when the system grows. However, one challenge that cannot be ignored is that this modular approach of replacing caps has limited the user's exploration of emergent functionality to some extent. In this design, emergent functionality mainly exists in how to play with "centralized" and "distributed" in locus control, mainly about custom grouping control for more granular functions under each core function. Yet the emergent possibilities between core functionalities is weak.

Also, an interesting reflection that discovered during the the design process is that the final design outcome is strongly affected by the entry point of the design.

In the beginning, the team chose "lighting" as the starting point for the design exercise for a rich interactive 'Locus of interaction' for a living room IoT device. In fact, because of the simplicity and rich variant it has, lighting often used as a touchstone to explore possibilities in new areas. There have been many cases of IoT devices for home lighting, which offered some inspiration but caused a certain degree of imagination at the same time. During the process of brainstorming while trying to leave out existing cases, the group found that the light often exists in the form of output. In the context of the family environment, it may exist in the form of illumination, tools for creating atmosphere and information carriers, especially when it serves as the information carrier, it becomes more like a notifier or a screen, which is exactly what the group wants to avoid at the beginning. After some experimentation, the function of picking the light color in the real environment was finally determined as the core function in the first iteration, thus, the form and interaction of the device were determined in line with this function. In fact, it is precisely because of this initial decision that it really controls the direction of design development. It can be found that all the elements in the first iteration can still be found in the output of the last iteration. When trying to solve the 'growing' challenge, in fact, the group did not seek help from the four "approaches to growth" at the beginning but made a very direct attempt. Only after further improvement was hindered, the modular approach was adopted because of its flexibility. It is safe to say that, if any other theme other than lighting was chosen in the first place, the approach used to design a growing system and the final outcome would be very different.

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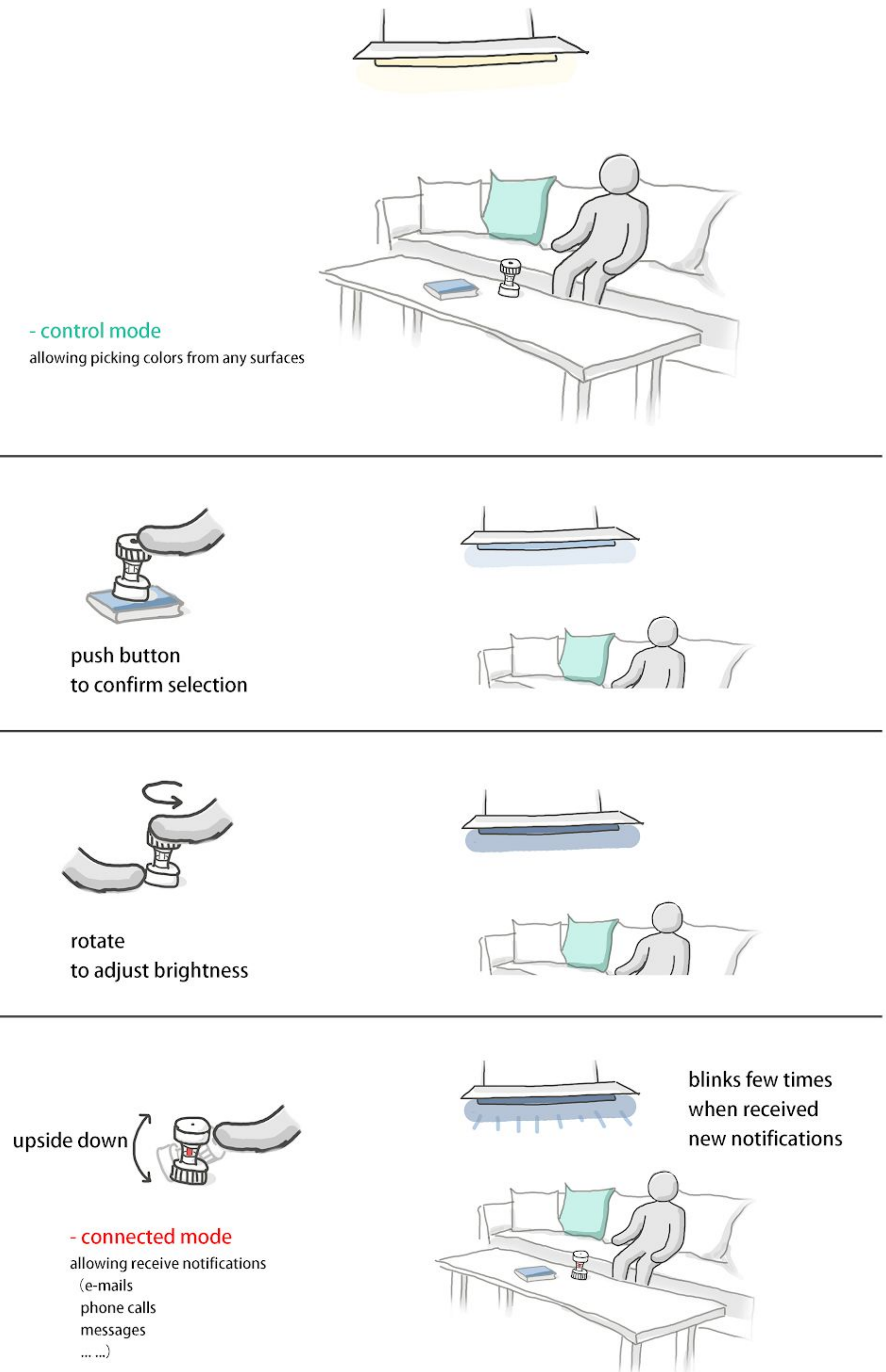
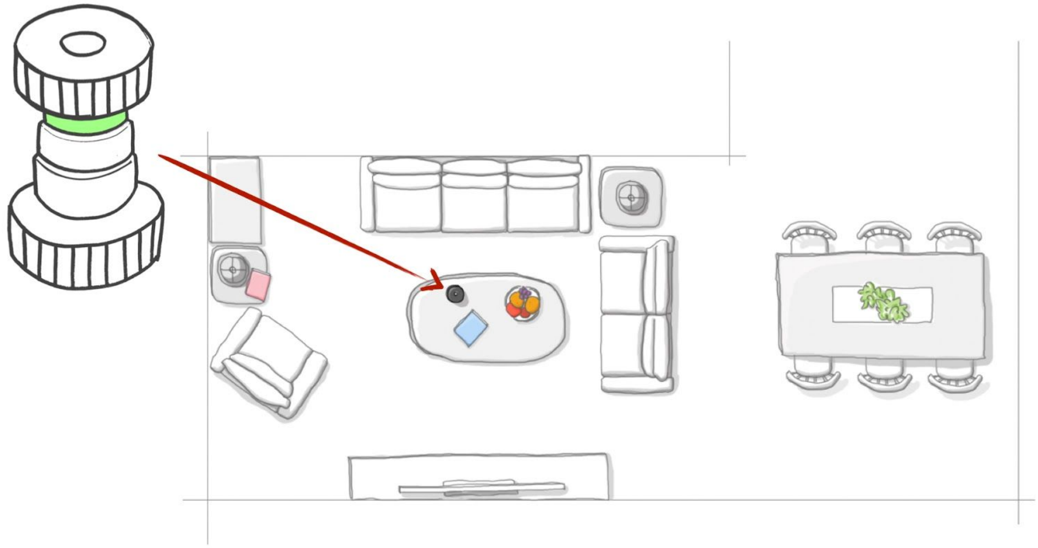
APPENDIX

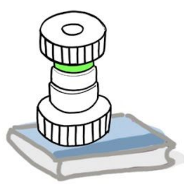
A. Storyboard in iteration II



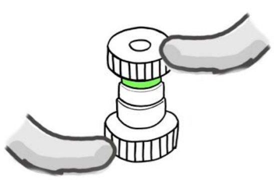
B. Storyboard in iteration III



Adjust the whole lighting system

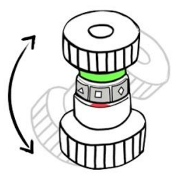


pick color

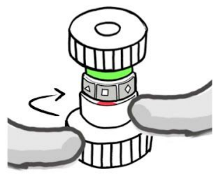


change brightness

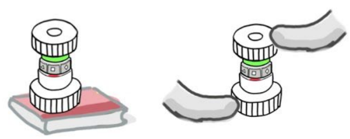
Adjust specific lighting group



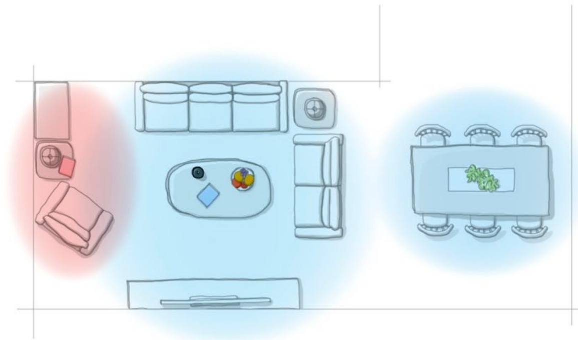
turn it over



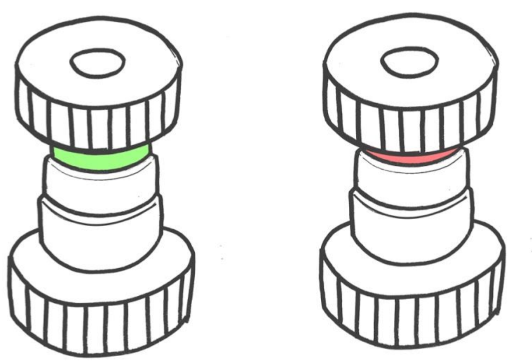
select group



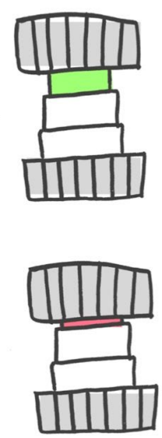
change color & brightness



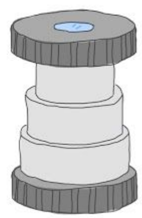
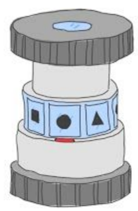
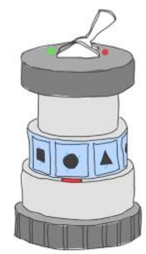
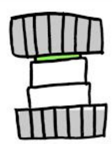
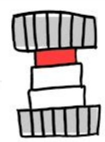
Energy indication



Volume & Color change according to the balance of Energy Consumption & Production



C. Function list of the device in the final iteration

Position	Functional Unit	Mode(with specific caps): lighting		air-conditioner		power supply	
middle ring **disabled**	screen on the top wheel		1. perform as a button to confirm color picking 2. display color		display room temp. & desired temp.	X	
	top wheel		control brightness of all the lights		control desired temp.		
middle ring **enabled**	screen around the middle ring		rotate to select lighting groups		rotate to select fanning areas		rotate to select power supply groups/devices
	screen on the changeable caps		1. perform as a button to confirm color picking 2. display color		X		X
	caps		control brightness of the selected lighting groups		control wind speed of the selected areas		deactivate/activate all devices belong to the selected groups
both	volume height	represents the speed of current power consumption  low speed  high speed					

Reflection

Yiwen Shen(M1.1)

Insights:
The interactive products nowadays are predominated with a digital screen. This phenomenon of design habit seems to continue its rapid growth. Rich interaction contributes solutions that it helps designers to explore the possibilities of tangible interaction.

Learning curve：
The reason why I made the decision to follow this elective was that I wanted to bridge the gap from the multimedia study (my previous education) to Industrial design. At the beginning of this elective, ‘rich interaction in growing systems’ seems to be a mysterious field to me. My knowledge about interaction design was only limited in website interactions or interactive installations. This elective was like an ‘eye-opening’ for me. When designing an interactive product, In practical, the products should not only satisfy a user’s needs but also creating meanings into their everyday’s life. However, there was no guideline to follow when designing them in my study experience. This elective introduced a framework ‘rich interaction’ coined by Joep Frans, ‘when designing a interactive product, designers should start from respecting human skills and aim for aesthetic interaction through the integration of form, interaction’. This framework positively helped me keep up with this elective because I was able to perform more actively in the teamwork of the group.

This elective, in my opinion, was very intensive to follow. The self-directed learning activities which included 1) literature reading and 2) conceptualization of each interaction was really important and necessary, from my experience, to finish on time. However, I sometimes still had some difficulties in following the lecture discussions. The ideation process of each iteration was a good design practice for me to apply the knowledge I have learned from this course, the way how the lecture was structure was also helpful, I enjoyed to see how other teams every time modified and improved their concept, I felt there was a growing learning curve through the entire elective for me as a designer.

What can I do better next time?
I have achieved a basic understanding of rich interaction and growing system, however, some other relevant knowledge in achieving more in-depth understandings yet limits my performance in this project. I would like to invest more time on some specific subject studies. I discovered prototyping skills with using 3D program plays a crucial role in design, thus I plan to invest more time on this subject in future.

Conclusion: This elective helped me to formalize sequences of using rich interaction framework to design an interactive product. It also raises the awareness of how a suitable framework can contribute to a design project. I have learned a lot from this course, not only the theoretical frameworks of rich interaction and growing system, but also gain practical experience to quickly apply this framework to new design projects.