Technology Reports
Personalization Home Devices Gesture Controlled UI
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Personalized Screen Concept Using a Gesture Controlled UI

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Smartphones have become widespread as devices for collecting a wide range of data, but users can feel stress at not always being able to get the information they need accurately. It can require significant time and effort to get such information. To solve this issue, NTT DOCOMO has proposed the "Personalized Screen" concept, which provides information in a natural form, even without the user actively try to get it.

1. Introduction

Mobile phones are currently the most widespread information devices and are used very frequently. Smartphones in particular have reached a penetration of 75.1% of all households in Japan [1]. They have become indispensable to users for getting all kinds of information and for communicating with others through SNS. On the other hand, an issue with smartphones is that users can feel stress if there are obstacles to communicating or getting information.

In a survey of smartphone users ranging from 9 to 25 years old, 35.4% reported, "I would say that I am dependent on the Internet" [2]. Another study reported that 47.4% of smartphone users reported, "I feel uncomfortable when I cannot use my smartphone as often as usual" [3]. Users cannot be without their smartphones, even when they are at home.

Users are able to get information using their smartphones anywhere and at any time, but there is a huge amount of information, and they must make appropriate choices to get the information they desire. Users must actively access information with a smartphone, performing searches and other operations, and this can require significant time and effort to obtain the information they want. For these reasons, some users subscribe to information distribution services so they can passively receive the information they need, or they receive notifications from specialized applications, but this does not necessarily always get them the information they want. In another survey, 33.4% of smartphone users reported that information services such as e-mail magazines that they subscribed to had become "Annoying" or "No longer useful" [4].

Another issue that has been identified with smartphones is that many users feel that the screen is too small for collecting information. 36.7% of users reported, "The screen is too small," when browsing on their smartphones [5], indicating that they would like a larger screen to display more information at once.

To reduce such stress felt by users, the information they desire needs to be displayed appropriately and on a large screen, so that they can enjoy it more passively. However, it is fundamentally difficult to provide appropriate information on a large screen as described above while away from home, so smartphones, which are very portable, are indispensable as information gathering tools.

Issues and stress in obtaining information as described above also occur within users' own homes. As such, NTT DOCOMO has proposed the "Personalized Screen" concept for home environments, as a solution that can display the desired information naturally, without requiring active effort from the user.

Personalized Screen is a home device designed to integrate comfortably with information gathering behaviors in the flow of users' daily lives. It enables them to obtain information without stress, and realizes a user experience which presents them with the desired information when it occurs to them, while they are relaxing at home. Another important element is to provide a User Interface (UI)*1 that is comfortable to operate and enables users to get more detailed information on their interests and concerns.

NTT DOCOMO has proposed other home devices on the theme of improving communication, such as petoco*2 and Tomokaku*3 [6] [7], but Personalized Screen is a new device concept, oriented to improving lifestyle environments.

This article introduces the Personalized Screen concept and a prototype, and describes evaluation of the device by users.

2. Personalized Screen Concept

The premise of Personalized Screen is to enable users to obtain information passively, so a key point is to display desired information naturally, without requiring users to actively retrieve the information themselves. Doing so, requires consideration of what information to display and how.

A comfortable way to operate the system is also necessary, to enable users to get more detailed information on their interests or concerns if they want to. As such, the following three points are important in realizing the Personalized Screen concept.

*1 UI: Operation screen and operation method for exchanging information between the user and computer.

*2 petoco: A home communication device developed, mass produced and marketed by E3 Inc., using technology developed by and licensed from NTT DOCOMO.

*3 Tomokaku: A handwritten communication concept proposed by NTT DOCOMO.

(1) Display of information is integrated smoothly into the flow of daily life
(2) Information is personalized
(3) A comfortable method of operation

2.1 Information Display Integrated Smoothly into the Flow of Daily Life

To integrate smoothly into their daily lives and provide them with information naturally, without causing stress, the desired information needs to be displayed at the desired location. A large screen is also preferable, so that more information can be displayed at once. There are many flat surfaces in a home, such as walls, tables, windows, and mirrors, but in most cases they serve a single purpose and are not used for displaying information. With Personalized Screen, these types of large surface, which exist naturally in our living environments, are used to display information (**Figure 1**).

Scenarios will differ for each user, but possible examples include using a living room wall or large-screen television to display information for the whole family, and walls in the bathroom, kitchen or bedrooms to display more personalized information. The display location is not restricted and is selectable by users, enabling them to get information naturally, within the flow of their daily lives.

2.2 Personalizing Information

The information users desire varies greatly, and can change according to place and time, even for the same user. To provide information to users without stress, it is important to discern the user and scenario, and optimize the information displayed from one minute to the next.

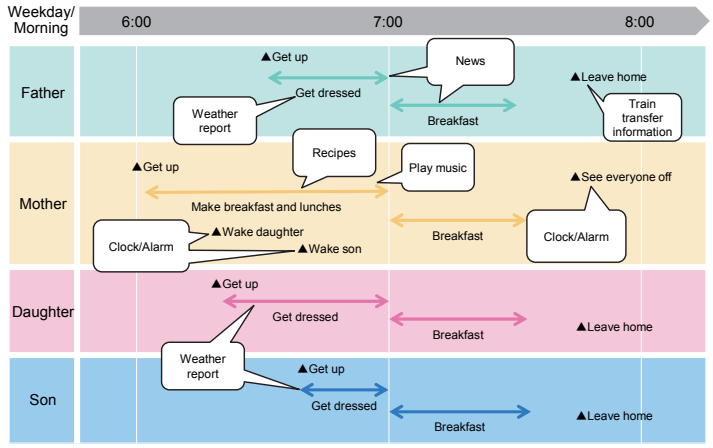
As an example, consider a family of four, with the father working in an office during the day, the mother a homemaker, a daughter in middle school and a son in elementary school. An example of their pattern of behavior and the information they need is shown in **Figure 2**. To give the whole family the information they need without causing stress, the information displayed must change automatically, without operation by family members. For example, weather forecasts could be displayed when the whole family is present, news and commuting information for the father, and recipes and alarms for the mother. During the day when only the mother

(a) Display on a wall

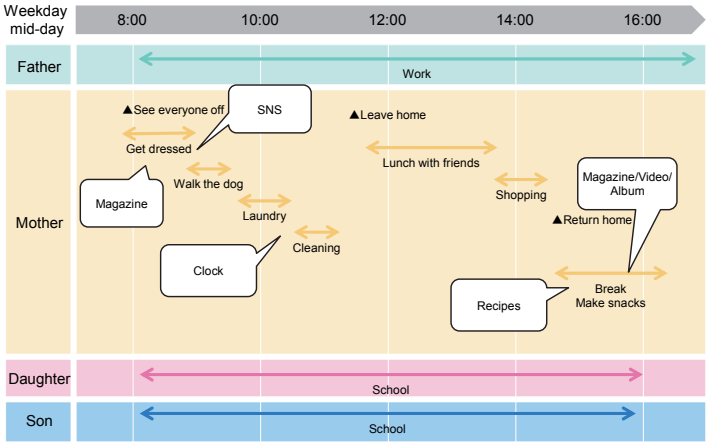
(b) Display in a window

(c) Display on a desk

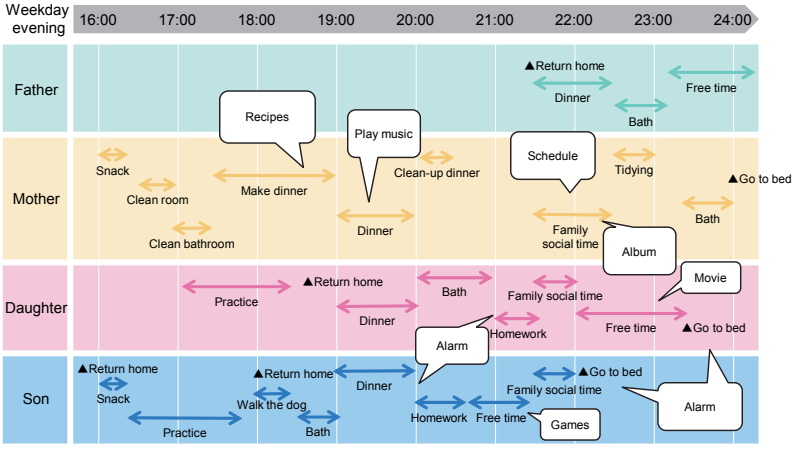
Figure 1 Use cases for the Personalized Screen



(a) Weekday morning



(b) Weekday mid-day



(c) Weekday evening

Figure 2 Example of family behavior patterns and required information

is home and the rest of the family are out, the information is specialized for her, which may include SNS, magazines, or movie information. Then, in the evening, the system resumes displaying information for the whole family again. The son and daughter can also continue enjoying entertainment content they were viewing on their smartphones, such as a game or a movie. And of course, the information needed will be different on the weekend than on weekdays.

The ability to display information optimized for individual or multiple users, and for the day and time, is an important element of Personalized Screen.

2.3 Comfortable Control Operations

Users will be able to get information they need from Personalized Screen without stress as described above, but they also need a way to get more detailed information about their interests and concerns comfortably.

Input InterFaces (IF) currently in common use include remote controls for television and other household electronics, mouse and keyboard for personal computers, and touch screens for smartphones. However, users must always have the remote control or mouse at hand in order to control a device. For touch screen operations, users need to touch the screen directly, which is difficult when far from the screen, or for larger screens that may not be within reach. There is also a risk that a device could be damaged when touched directly. All of these input interfaces require troublesome actions such as searching for the remote, or approaching the device to perform operations. When users cannot reach the controller or device, such as while cooking or taking a bath, they cannot perform operations at all.

As such, we have proposed using gestures as a comfortable mode of operation. Gestures allow operation without a controller and from a distance, so they support a range of use cases within a home, and are an optimal input interface for a home device integrated smoothly into the flow of daily life.

3. Prototype and Evaluation

To evaluate the Personalized Screen concept, we prototyped an application capable of gesture operations. We conducted user reviews and exhibits projecting images onto a large screen and obtained feedback from users. We describe the prototype and evaluation results below.

3.1 Information Display Functionality

When the application is launched, the home screen is displayed. It then updates, periodically and automatically, arranging various content on the screen so that users can get information by just looking at it. The system uses a camera with facial recognition to determine the number of users and differentiate them, to provide content that is expected to be of interest to the users who are present. For example, if several users are present, content of common interest, such as news or a shared scheduler could be displayed, but for a single user, content such as their SNS feed could be displayed.

The system can also display content synchronized with a user's smartphone history, such as the continuation of a movie that was being watched on a smartphone, or it can notify of updates to products that the user searched for earlier.

To enable users to get more detailed information

regarding their interests or concerns, operations can also be done on any of the content on the home screen. By waving a hand up and down or left and right in front of the gesture recognition camera, a cursor can be moved over the content. Then, for example, more information can be found by scrolling on the news screen, or playback of music or video can be started or paused. When any of the content is selected, it is launched and displayed using the whole screen, so that the user can browse content or watch video on the large screen.

Images of actual screens are shown in **Figure 3**. They represent weekday scenarios for the family described in Section 2.2. The screen for the whole family in the morning is in the upper-left, the family screen in the evening in the upper-right, the mother's daytime screen in the lower-left, and the father's evening screen in the lower-right.

3.2 Gesture Operation

We used gestures for the input interface, as a comfortable way of operating Personalized Screen. In the process of testing the prototype, we learned that to implement comfortable gesture operations, we needed to define a gesture scheme and improve the accuracy of gesture recognition, but we would

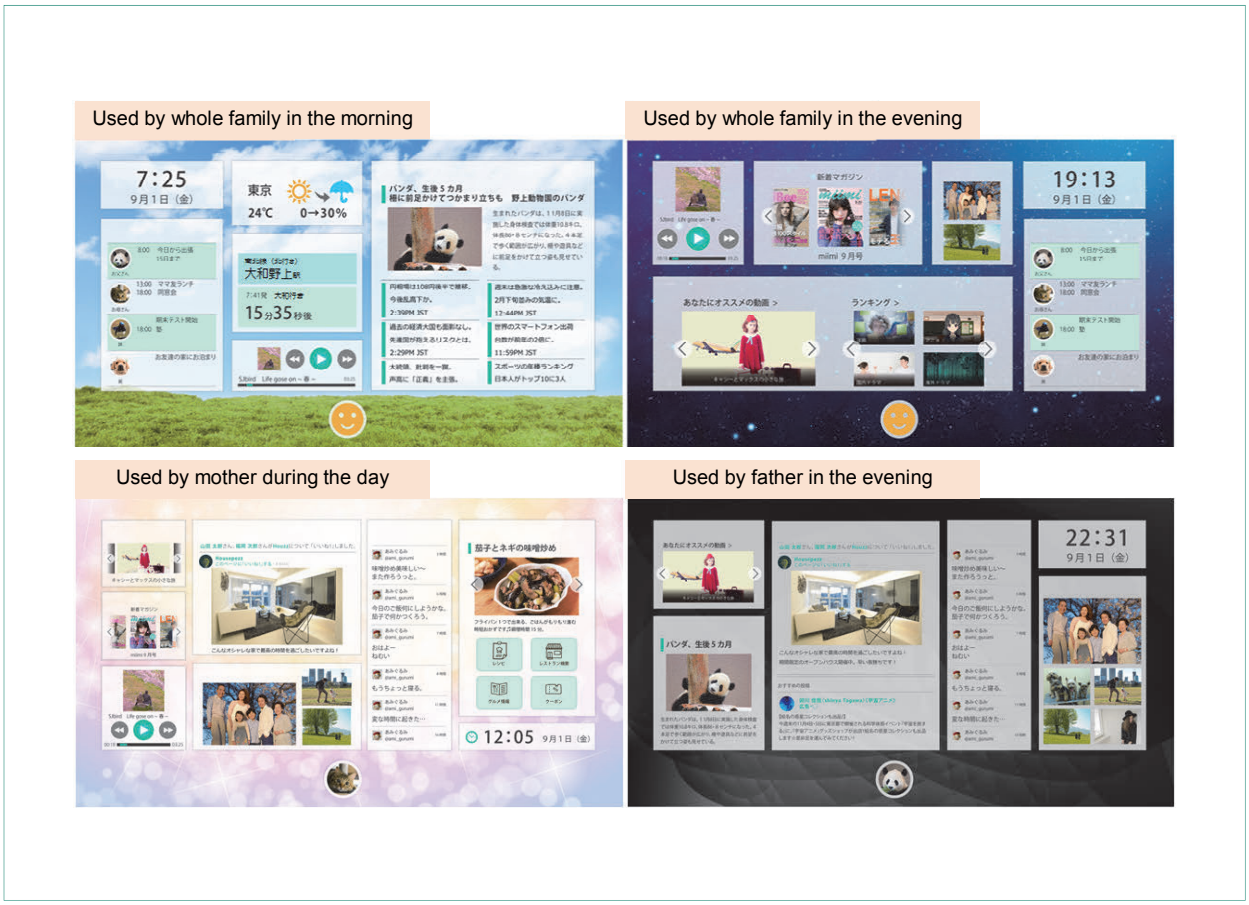


Figure 3 Prototype application screen shots (content depends on the user and the time of day)

also need to optimize the screen display for gesture operations. Thus, for this prototype, we optimized both the gestures and the screen display as described below.

The greatest difficulty we found with gesture operations was that behaviors unintended by the user were selected and performed. To prevent this with the prototype, we first recognize the user's palm, and then only allow three different gestures, which were grasping, waving the hand left and right, and moving the hand up, down, left and right. We did not define gestures that were similar, making it more difficult to recognize gestures incorrectly and perform unintended operations, and we required recognition of the palm before accepting operations to reduce the margin for such operations.

We also did not display a pointer on the screen, and used a cursor to indicate which content to operate on. This was because compared to using a mouse or touch screen, we found that it is difficult to perform detailed operations using gestures, and that inconsistencies between the pointer and their sense of their own body made performing operations tiring. We also arranged the home screen with a small number of large rectangles rather than many small icons, as on a smartphone home screen, to avoid the need for fine operations.

We also played sound effects and magnified the display of the content indicated as the cursor was moved by the user. This was done to provide feedback to the user, because gestures do not provide feedback in the way that touching a screen or clicking a mouse does.

We also defined gestures to start and stop scrolling on the screen. We did this rather than defining screen scrolling operations as on a smartphone, because such gestures would require large movements with the whole arm, which could cause fatigue. We were able to reduce such fatigue by designing the prototype to continue scrolling automatically once started.

Finally, we improved operability by confining the recognizable motions to the 2D plane of up, down, left and right. Initially we studied gestures with motion in 3D, such as selecting content by pushing your hand forward in the depth direction. However, unlike actions in the real world, using a gesture does not provide any sensation of actually touching the content, so users had no intuitive sense of how far they needed to move their hands to perform an operation. This made it very difficult to control. Users also actually moved their hands forward or back, even when they only intended to move them in the up/down/left/right plane, and this caused them to select content that they had not intended. For these reasons, we decided that using 2D operations was optimal.

3.3 Evaluation

The prototype described above was exhibited at an event titled, "Encounter the revelation of "near" future: - 5G creates lifestyles of future -" jointly held by NTT DOCOMO and the National Museum of Emerging Science and Innovation ("Miraikan") from November 9 to 11, 2017. Approximately 600 users were able to experience our concept. We conducted a user survey at the same time, and discuss the resulting comments and evaluation below.

1) Evaluation of the Personalized Screen Concept

(1) Favorable comments

We received many favorable responses. On opinion was that the idea of automatically

displaying information optimized to the user's needs while synchronizing with their smartphone was very interesting. Another user said that they only watch the television in the morning to see the time, so displaying other useful information in this way was very good. We received positive comments regarding the concept from almost all participants.

(2) Points for improvement

Some users expressed concern for privacy, because the concept is that the content displayed depends on whether the display is shared or used by one person. For example, the system could display on a large screen personal information such as text messages that the user does not want to share with other people in the room.

2) Evaluation of Gesture Control

(1) Favorable comments

There were many comments saying that the system was easier to operate than expected, and that being able to operate it remotely using gestures felt futuristic. Many participants agreed that being able to operate a large screen from a distance was good, confirming that using gestures for operation fit very well with our concept.

We also received a comment that the concept could be applied as a solution for the elderly, due to its simple, intuitive operation.

(2) Points for improvement

We received mostly positive responses regarding usability, because we worked hard to address issues with gestures, but we still received a few comments such as, "It didn't always work as I expected," and "I found it tiring," when compared with mouse or touch operations.

3) Evaluation Summary

Generally, we received positive responses to our Personalized Screen concept, but improving personalization and protecting privacy remain as issues, so we want to continue studying improvements in these areas.

We also confirmed the effectiveness of operation using gestures. On the other hand, although we designed the system with consideration for preventing operation errors and fatigue, we also received a few comments that this was not adequate, so more work to improve operability is needed.

4. Conclusion

We have described the Personalized Screen concept, which is a home device that is able to display information needed by users naturally, integrating smoothly into the flow of their daily lives. The positive response it received at "Encounter the revelation of "near" future: - 5G creates lifestyles of future -," exhibition and positive evaluations from users suggest that users were receptive to the concept. In the future, we will continue study of issues identified in the evaluation, working toward commercialization of the concept, and also examine applications in domains other than home devices.

REFERENCES

[1] Ministry of Internal Affairs and Communications: "Results of 2018 Survey of Telecommunication Usage Trends (June 22, 2018 Rev.)," May 2018. http://www.soumu.go.jp/johotsusintokei/statistics/data/180525_1.pdf

[2] Ministry of Internal Affairs and Communications: "Institute for Information and Communications Policy – Survey of Internet Use and Dependency Trends among Youth," Jun. 2013.
http://www.soumu.go.jp/iicp/chousakenkyu/data/research/survey/telecom/2013/internet-addiction.pdf

[3] Just Systems Inc.: "Field Survey of Smartphone Dependency," Sep. 2012.
https://marketing-rc.com/?_ppp=8a9cfe684b&c=881515ae4823e912-00&p=3617&preview=1

[4] PR TIMES: "Report on Survey of Smartphone Notifications. 70% of People Check Push Notifications! 60% of People Store up e-mail newsletters without reading them! | Emprize Press Release," Jun. 2015.
https://prtimes.jp/main/html/rd/p/000000008.000012737.html

[5] Impress: "Gender differences in dissatisfaction with Smartphone Web browsing; Improvements must match the target users/Smartphone Report Vol. 5-1 | Smartphone Report | Web Administrators Forum," Feb. 2013.
https://webtan.impress.co.jp/e/2013/07/10/15118

[6] K. Murakami: "petoco": A Home Communication Device," NTT DOCOMO Technical Journal, Vol.20, No.2, pp.32–41, Nov. 2018.

[7] K. Ishiguro, et al.: "Tomokaku": A Handwritten Communication Concept," NTT DOCOMO Technical Journal, Vol.20, No.2, pp.42–51, Nov. 2018.