

Universal Design Activities for Mobile Phone: Raku Raku PHONE

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Fujitsu's Raku Raku PHONE is an easy-to-use mobile phone for elderly persons, persons unfamiliar with mobile-phone operation, and persons with physical disabilities, for example, persons with visual disabilities. This highly accessible, user-friendly mobile phone makes full use of speech synthesis and voice recognition technologies and achieves good universal design through an ingenious combination of hardware, software, and user interface. In the development phase, we adopted a special process to aggressively research and evaluate product usability from users' viewpoints, clarify existing problems, and improve the design and user interface of mobile phones. This paper describes the steps taken to achieve universal design in the Raku Raku PHONE and the universal design features of its hardware, software, and audio functions.

1. Introduction

Japan is rapidly aging. There are 24.8 million Japanese people age 65 or older, accounting for 19.5% of the entire population (as of January 2004).¹⁾ Meanwhile, the mobile phone market in Japan continues to expand. The Research on Mobile-Phone Utilization Ratios (in fiscal 2003)²⁾ indicates that 84.4% of the entire population uses mobile phones in a maturing market. Conversely, only 54.1% of males and 40.2% of females in their 60s are mobile-phone users, thus indicating a delayed proliferation of mobile phone use among elderly persons. As the market matures, both telecommunications carriers and mobile-phone makers have initiated discussions about how to increase the number of elderly mobile-phone users for further expanding the market and what obstacles should be overcome to achieve this purpose. Since mobile-phone functions have become increasingly complex, there has also been a growing demand for mobile phones that can be easily

used by everybody. In response to these circumstances, Fujitsu developed the Raku Raku PHONE.

Raku Raku PHONE is the brand name used by NTT DoCoMo, Inc. for mobile phones designed for easy use by elderly persons, persons unfamiliar with mobile-phone operation, and those with declining physical abilities (e.g., visual disability). Fujitsu has supplied NTT DoCoMo with four generations of mobile-phone products, such as the "mova" F671i (released in September 2001), "mova" F671iS, "mova" F672i, and the latest "FOMA Raku Raku PHONE" F880iES (**Figure 1**), which supports the W-CDMA system.^{note 1)} Thus, Fujitsu has helped nurture the Raku Raku PHONE market while steadily expanding the stratum of its customers. These mobile phones have continued to evolve through a series of generations. These devices not only

note 1) "mova", "FOMA", and "i-mode" are registered trademarks of NTT DoCoMo, Inc.



note) From left: dark green, bronze, and silver. Pink was added in February 2005.

Figure 1
FOMA Raku Raku PHONE F880iES.

offer high-performance, convenient functions, but also well-considered usability features based on universal design (UD) in various parts of hardware and software.

The Raku Raku PHONE has the following usability features developed from the standpoint of universal design:

- 1) Simple, user-friendly interface designed for easy use even by persons unfamiliar with mobile phones

The Raku Raku PHONE has been provided with a special user interface designed in consideration of those with little experience in using mobile phones and who cannot manipulate the devices intuitively. In response to the needs of a maturing market, the Raku Raku PHONE has been equipped with new functions (e.g., popular e-mail and camera functions) to help users readily join circles of mobile communication.

- 2) Various features to assist users with visual disability

The Raku Raku PHONE has features to support visual functions along with audio features, as well as an easily viewable display. The audio features include the text reading feature based on Fujitsu's original speech synthesis technology and the voice-activated call feature based on voice

recognition technology (for speaker-independent). These features are also convenient for people without physical disabilities.

This paper describes the steps taken to implement universal design of the Raku Raku PHONE and its hardware, software, and audio features as actual examples of universal design.

2. Steps to implement universal design of Raku Raku PHONE

The development process for the Raku Raku PHONE includes more elaborate research and evaluation of usability than for standard mobile phones because the intended product characteristics require that we consider the opinions of users and observe their behavior when using the product (**Figure 2**). We recruited mobile-phone users and nonusers with assumed user attributes (e.g., ages 40 to 60) as test subjects, conducted both a sensory evaluation by using the center location test (CLT)^{note 2)} in ordinary development as needed, and the interview and test below, then reflected the evaluation results in the product.

- 1) Group interview to determine latent needs and discontent
- 2) Usability test and heuristic evaluation^{note 3)} to appraise product usability

For some evaluation items, we interviewed persons with visual disabilities to obtain their opinions in collaboration with schools for the blind.

Regarding visual support, we designed and validated screen display with the greatest care for the following requirements:

- 1) Sufficiently large size of characters
- 2) Elimination of presenting information using only colors
- 3) Optimum color scheme

We checked the color scheme by using Color Selector of Fujitsu Accessibility Assistance^{note 4)} as

note 2) A research method in which test subjects gathered at a testing location use the actual products or samples for evaluation.

note 3) An evaluation method in which multiple evaluators describe interface problems based on defined heuristics.

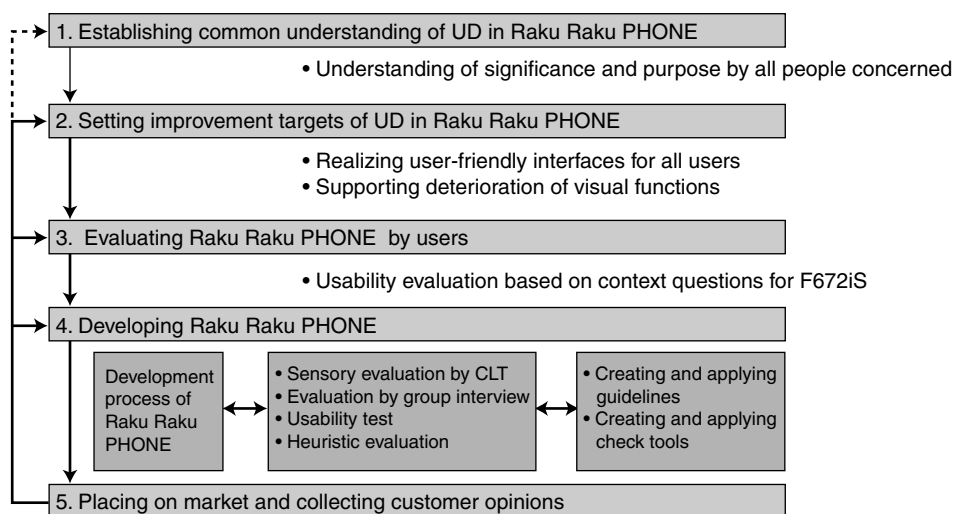


Figure 2
Steps toward achieving universal design in Raku Raku PHONE.

needed to make the screen easily viewable for the visually disabled.

The subsequent sections describe the hardware, software, and audio features of the Raku Raku PHONE as actual examples of universal design realized by our steps taken to implement universal design.

3. Hardware design of Raku Raku PHONE

This section describes the buttons and display that are designed for easy use even by persons unfamiliar with mobile phones as examples of universal design.

3.1 Buttons

To ensure high operability, the Raku Raku PHONE has sufficiently large buttons located at sufficient intervals and protruding at least 0.5 mm from the body surface. Users can sense button

positions with their fingertips and comfortably perform input operations without making any errors. The buttons bear sufficiently large characters in a highly visible typeface printed in high contrast to the background to avoid incorrect reading. The Start and End buttons are shaped differently from other buttons so that the user can easily distinguish them either visually or by touch [Figure 3 (a)].

Because the FOMA Raku Raku PHONE F880iES supports a videophone function, it is equipped with a light navigation feature that lights the buttons to be operated when a videophone call is received [Figure 3 (b)].

The three one-touch dialing buttons located under the main LCD (Liquid Crystal Display) enable the user to make a call to a pre-registered destination by simply pressing one button [Figure 3 (c)].

To prevent incorrect button operation, each one-touch dialing button is designed to function only when held down for at least one second.

3.2 Display

The FOMA Raku Raku PHONE F880iES is equipped with a large (2.4-inch) quarter video graphics array (QVGA) TFT color LCD (240 by

note 4) Generic name of the screen design diagnosis software tools used to improve screen accessibility for persons with visual disabilities or color blindness. Fujitsu Accessibility Assistance conforms to JIS X 8341-3 and is available free of charge from Fujitsu Design Center at “<http://design.fujitsu.com/jp/universal/assistance/index.html>”.



(a) Easy-to-use and easy-to-find buttons



(b) Light navigation feature



(c) One-touch dialing buttons

Figure 3
Button design.

320 pixels) as the main display that can show large-size characters.

The sub-display on the back is of a landscape 1.2-inch monochrome type (STN monochrome LCD) that can show large characters and is easy to read even when the backlight is off due to time-out (**Figure 4**). The high contrast set between displayed characters and the background enhances visibility.



Figure 4
Rear sub-display.

4. Software design of Raku Raku PHONE

This section describes the software features of the Raku Raku PHONE that provide most users with an easily viewable and understandable user interface, as examples of universal design.

The user interface of the FOMA Raku Raku PHONE F880iES has the following features:

1) Large easy-to-read characters

Use of the large, high-definition, 2.4-inch QVGA color LCD enables the display of large, smoothly outlined characters that are easy to read and highly viewable [**Figure 5 (a)**].

2) Inverted screen display

The color scheme of the screen is designed to be variable, allowing selection between conventional, normal display mode and inverted screen display, which is conspicuous to elderly persons and persons with visual disability [**Figure 5 (b)**]. The color variations of hardware parts also include an inverted color arrangement featuring black buttons printed with white characters.

3) Camera and videophone functions

The FOMA Raku Raku PHONE F880iES is equipped with a camera function strongly demanded by conventional Raku Raku PHONE users and the videophone function unique to FOMA models. Both functions are user-friendly thanks to easy-to-understand operation procedures and simple screen display [**Figure 5 (c)**].



Figure 5
Operation screens of Raku Raku PHONE.

4) Enhanced guidance function

The on-screen visual guidance for operation has been enhanced with large display to improve comprehensibility [Figure 5 (d)].

5) Improved usability of e-mail functions

The FOMA Raku Raku PHONE F880iES is equipped with a simple mail function for easily composing mail text according to on-screen guidance and an audio mail function for sending voice mail instead of text. Even users unfamiliar with e-mailing can easily use these functions.

5. Audio functions of Raku Raku PHONE

This section describes the usability features of audio functions of the Raku Raku PHONE. The features reflect careful consideration of the usability of the text reading function, an improved text reading function (based on evaluated usability), the formulation of an accessibility guideline for i-mode sites, and support of a voice-activated call function.

5.1 Consideration for usability of text reading function

The Raku Raku PHONE has a text reading function based on Fujitsu's original speech synthesis technology to help users easily under-

stand display content both visually and aurally. The text reading function covers a wide range of content, including i-mode sites, guidance for operation, e-mail, and a phone book. The following describes the available methods of reading i-mode sites and the policy on pictograph reading, all of which are designed to improve usability.

1) Methods of reading i-mode sites

There are two methods of reading the page of an i-mode site: "full-text reading" reads the entire text on the page aloud at one go; "sectional reading" reads a section (a sentence or paragraph) of the page aloud (Figure 6). Since i-mode pages usually contain many links, we determined that it would be more effective to stop the focus at a link. Therefore, for the i-mode text browser, we set sectional reading as the standard reading mode and full-text reading as an optional mode to be selected by the user. In sectional reading mode, the user must move the focus from the current read section to the next section to be read. However, moving the focus is not very troublesome because each i-mode page contains less information than a Web page designed for access by personal computers.

2) Pictograph reading

Pictographs are often used on i-mode sites and in e-mail for two different purposes: to add

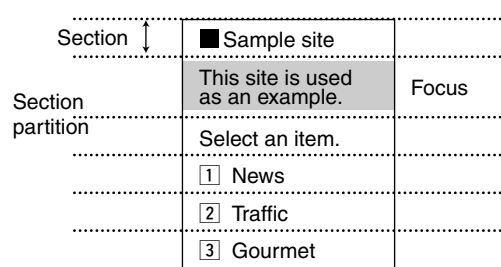


Figure 6
Concept of sectional reading.

visual supplements; and to substitute linguistic information or meaning as original characters. Most pictographs used for the first purpose need not be read aloud. Conversely, the pictographs used for the second purpose are important when a pictograph shown at the top of a line alone implies the meaning of subsequent text that is to be omitted or when a pictograph appears in the text. For these reasons, we designed the text reading function of the FOMA Raku Raku PHONE F880iES to read every pictograph aloud.

5.2 Improved text reading function based on evaluated usability

The following explains the usability evaluation we conducted using the mova F672i (from the user's standpoint) to make the text reading function easy to use for expected users, and the contents of improvements made based on the evaluation.

We conducted the evaluation using the i-mode text reading function (automatic reading mode) of the mova F672i and an evaluation method similar to contextual inquiry with emphasis on interviews with persons with visual disability. We made improvements to the latest model (FOMA Raku Raku PHONE F880iES) based on usability problems determined by the evaluation.

1) Improved status recognition during page acquisition

There was a problem whereby nothing was read aloud during page acquisition from an i-mode site, thus preventing the user from aurally know-

ing that the phone was in communicating status. To resolve this problem, we improved the text reading function so that the phone reads the messages "Now connecting to i-mode site" and "Now downloading a page" aloud to inform the user of the phone's communicating status.

2) Improved sectional reading function

One evaluation result found that many users proceeded to the next step before fully reading the current section. For example, in a section containing a weather report, news, and other information, the user unintentionally moved the focus to the next section after the weather report and often failed to hear the news and other information being searched. We made an improvement so that the FOMA Raku Raku PHONE F880iES generates a beep sound at the end of each section.

3) Improved screen scrolling function

Conventional models had a function to scroll each individual screen when the user holds down the * and # keys for a specified time while reading i-mode text. However, this function was difficult to manipulate. We improved the function so that the FOMA Raku Raku PHONE F880iES only scrolls one screen even when the keys are held down longer than necessary. This improvement prevents the user from losing track of the section to be read aloud and enables easy movement between sections within the page.

4) Improved pictograph reading

Conventionally, all pictographs read were the titles of pictographs in the lists of basic pictographic characters and extended pictographic characters defined by NTT DoCoMo. However, defined titles sometimes did not match the contextual meaning. On the FOMA Raku Raku PHONE F880iES, each pictograph is read aloud as the "** mark" (**: title of each pictograph). For example, the "fair weather mark" and "bank mark" are read aloud.

5.3 Formulation of accessibility guideline for i-mode sites

The i-mode text reading function has been

reviewed for full reading of existing i-mode sites. On the other side, i-mode sites should be designed in consideration of accessibility to further enhance reading quality. We formulated an accessibility guideline for the content authors of i-mode sites. This accessibility guideline was intended to enable full utilization of the mobile phone's text reading function, and has been released to the public as the "Guideline for creating i-mode content matching text reading."³⁾ The guideline consists of four parts: "Overview of i-mode text reading," "Guideline (sample descriptions)," "List of symbol readings," and "List of pictograph readings."

5.4 Support of voice-activated call feature

The Raku Raku PHONE has a voice-activated call feature that allows the user to invoke various functions and make calls to pre-registered destinations by voice without any complex operation. This feature incorporates voice recognition technology using a voice segment network system that can recognize the voice of a speaker-independent with 95% accuracy or more.

6. Future issues

To make the Raku Raku PHONE accessible to more users, the speech synthesis and voice recognition technologies incorporated in the FOMA Raku Raku PHONE F880iES should be further refined and the range of application expanded to enhance the features that support users with disabilities. It is also necessary to incorporate these features based on cutting-edge technologies (e.g., speech articulation rate change) and a new type of interface using a touch panel to improve the mobile phone in terms of usability. In any case, the research and evaluation described above must continue in order to verify user-friendliness of the phone.

The elderly population is steadily increasing and user needs are expected to become more diverse than ever before. In the future, we should not only enhance usability according to JIS X 8341 (Guidelines for older persons and persons with disabilities), but also actively recommend new ways of using and enjoying the Raku Raku PHONE to users.

7. Conclusion

This paper described the usability of the Raku Raku PHONE, which is also accessible to elderly and disabled people, and our activities conducted toward implementing universal design in terms of usability.

The mobile-phone market is maturing as mobile phones have become popular. Makers are inclined to release special products designed to meet the individual needs of targeted users based on thorough marketing analysis. The Raku Raku PHONE is often regarded as a product that is specially intended for elderly and disabled people. However, making a product designed for use by anybody instead of a special product should be an approach that embodies the concept of universal design. We believe that this approach should be the corporate social responsibility (CSR) of companies in Japan, which is a rapidly aging country. We will also continue to improve and develop Raku Raku PHONE models from this perspective.

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