Next-generation Ubiquitous Device for New Mobility Society: Next-generation Cane

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Fujitsu develops products under a "human-centric" philosophy that seeks to leverage the power of information and communications technology (ICT). Its Human Centric Engine (HCE) incorporated in smartphones is a typical example of a technology that can provide easy-to-use products along with safety and security. Applying mobile sensing technologies developed and enhanced over many years, HCE has become a core component of user support functions. Fujitsu has studied the application of HCE to other products with the aim of supporting people in their everyday lives and has developed an advanced type of walking stick called the "Next-generation Cane." This paper describes the technical aspects of developing this novel product from studies of basic specifications to actual prototype development. It also discusses reactions to the Next-generation Cane at exhibitions and demonstrations and touches upon future developments.

1. Introduction

As the broadband wireless infrastructure driven by LTE and Wi-Fi technologies expands, and high-speed-processing and high-integration device technologies in CPUs and memory devices advance, attention is turning to smart devices ranging from portable terminals such as smartphones and tablets to wearable terminals such as head mounted displays (HMDs) and watch-type devices.

In response to these market needs, Fujitsu seeks to develop products and services that are easy to use under a "human-centric" philosophy. Such products and services were first placed on the market in 2011 as an integral part of smartphones. These original Fujitsu technologies for improving ease-of-use have evolved into a Human Centric Engine (HCE) that has been well received by the market as a core component of smartphones and tablets that can improve functionality and reduce power consumption significantly (**Figure 1**). At the same time, Fujitsu has been studying ways of using HCE in a form that provides comfortable and natural support for users, and one development to come out of these studies is Fujitsu's "Next-generation Cane" for the elderly.

In this paper, we explain our goals in developing the Next-generation Cane and describe the technologies behind this novel product.

2. Development approach to Next-generation Cane

Fujitsu has consolidated in HCE improvements in making the basic functions of "seeing, hearing, and talking" easier to use with improvements in 24/7 elderly-monitoring functions for enhanced safety and security. These improved functions have evolved to become proprietary functions in smartphones and tablets.[1)]

In addition, Fujitsu has considered that one way of broadening the application range of these HCE functions would be to implement them in other devices that users are familiar with in their daily lives. The idea is to embed an LSI incorporating HCE functions (HCE-LSI chips) in automobiles, everyday articles, etc. so as to provide added value in the form of elderly-monitoring services, health-support services, etc. for enhanced safety and security (**Figure 2**).

In its study of how HCE-LSI chips could be used to provide value by adding information and communications technology (ICT) functions to everyday articles, Fujitsu took up the cane (walking stick) as a

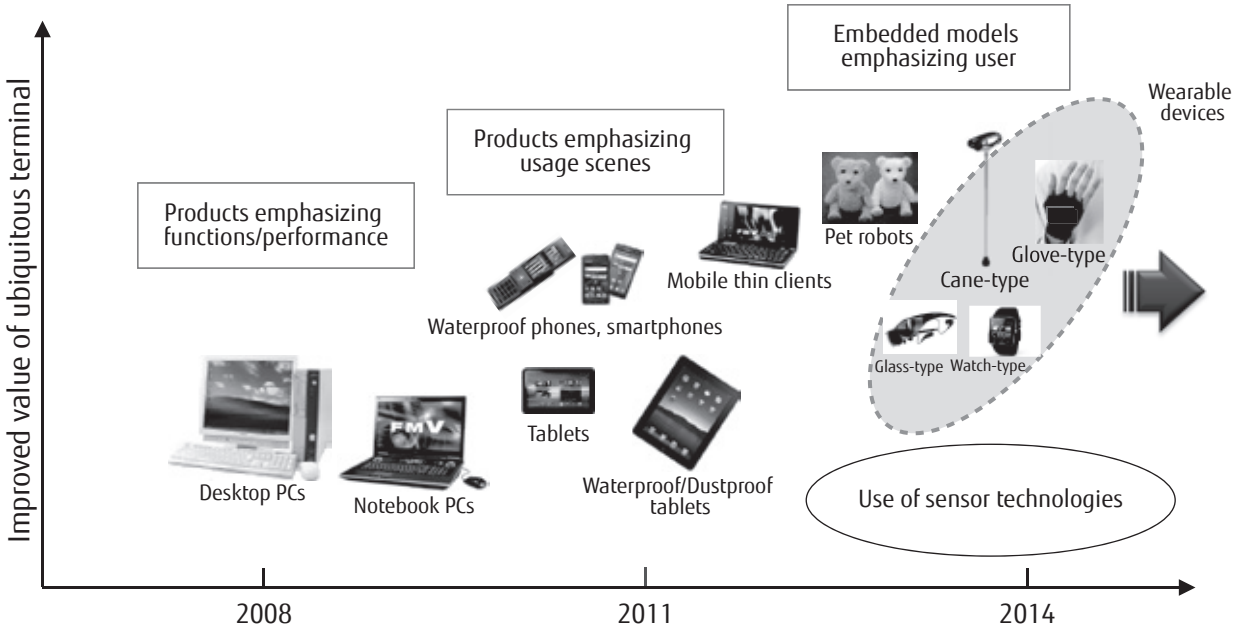

Figure 1
Evolution of HCE-equipped products.

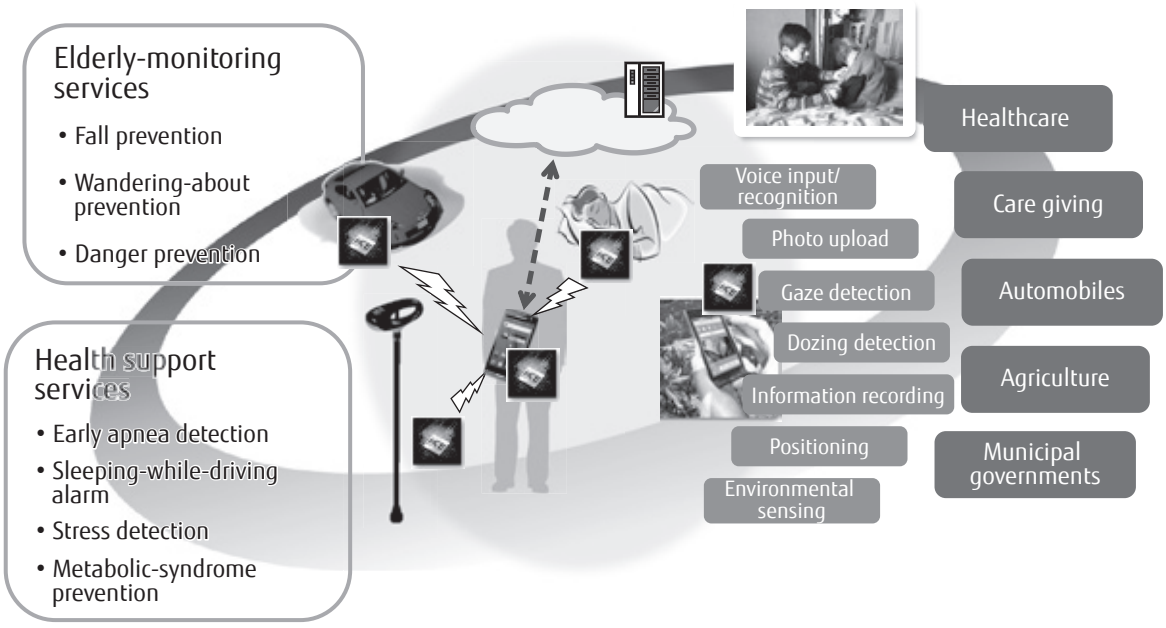

Figure 2
Providing added value through HCE.

familiar item frequently used by the elderly and walking-impaired persons to aid in walking. The following steps were taken with the aim of constructing a prototype Next-generation Cane that would transform the everyday walking stick into an ICT device and expand its use by linking, for example, with map data.

2.1 Service image

We studied what kind of value could be provided to the customer when giving a tool like a cane

ICT functions and formulated a service image. In this study, we adopted a problem-solving approach and a value-enhancement approach as explained below.

1) Problem-solving approach

To begin with, we analyzed the frequency with which the elderly go out and the anxiety or discomfort they may feel on going out. We found that even though nearly half of all elderly persons go out practically every day, many of them have mobility-related insecurities such as "roads have stairs, bumps, and inclines, and sidewalks are narrow" and "public transit such as buses and trains are hard to use."[2] We also found that obtaining pertinent information in real time (e.g., degree of danger in relation to automobile traffic and frequency of traffic accidents) and providing services based on that information has the potential of alleviating many elements contributing to such anxieties. On this basis of this knowledge, we equipped the Next-generation Cane with a variety of sensors for sensing people and peripheral conditions and with communication functions for connecting those sensors with services.

2) Value-enhancement approach

The reasons for going out of one's home can be classified into walking, shopping, long-distance movement, and sightseeing/traveling, so we investigated what kind of device a user would likely be carrying for each of those cases and what value could be provided through each such device. For the case of sightseeing or traveling, for example, if the user's travel route and destination were to be registered beforehand, we can imagine just-in-time services such as a travel guide that provides helpful information or support at the user's present location or a function for issuing coupons for use during the trip.

2.2 Development concepts

In our studies, we were aware that findings based only on information gleaned from the Internet or discussions within the development team could at times be out of touch with the actual needs of target users. For this reason, we interviewed managers at Carenet, a Fujitsu Group company specializing in daily-care and caregiving services, to learn more about the behavior and nature of the elderly, considering that they would have a good grasp of how the elderly—our target customer—actually live. From these interviews, we learned about resistance to using a cane (men in particular feel embarrassed about it) and attitudes toward mobile phones (strong sense of being forced to use them as opposed to using them voluntarily). Based on this information, we proceeded with our development of the Next-generation Cane based on the following concepts.

- Create a futuristic design that looks good and makes using a cane nothing to be embarrassed about and even something to boast about.
- Incorporate functions that can eliminate anxieties among the elderly about going out, particularly when visiting unfamiliar locations while traveling, and that can also provide peace of mind not only to elderly persons using the cane but also to their families.

2.3 Design/UI

We adopted a design with a circular handle as a novel form not previously seen in canes (**Figure 3**). Furthermore, in terms of a user interface (UI), we placed an LED dot matrix display under smoked acrylic to elicit a futuristic feeling and make it appear that useful information rises to the surface of the cane. Additionally, keeping in mind that a cane is constantly being grasped when in use, we equipped the cane with a vibration function to alert the user that new information is being displayed.

2.4 Functions and implementation

We decided to make use of a printed circuit board (PCB) for a smartphone to implement desired functions in the cane to make the development process more efficient and lower costs. However, the section of the cane that would enclose this smartphone PCB was circular because of the basic design that we selected,

Figure 3
Proposed design for Next-generation Cane.

so arranging this square-shaped PCB in an enclosure with many curves would hardly be efficient and would just make the entire enclosure larger. We therefore identified those smartphone components that have low priority from the viewpoint of cane functions and that would not present a problem to system operation on the whole even if removed. For example, it would be difficult to imagine voice calls while using a cane. However, it was not simply a matter of removing the receiver and microphone but rather a case of removing only the portions of such parts that affect size so that those devices appear to be mounted directly on the circuit board. In short, we identified the necessity of each and every component and investigated ways of removing any unneeded parts.

Downsizing and making development more efficient in this way facilitated incorporation of a heart rate sensor and LED dot matrix display, which are characteristic functions for monitoring elderly persons. We also studied mechanism design and component placement from the viewpoint of achieving good weight balance and cane strength so as to prevent any problems in actual use.

3. Achieving the Next-generation Cane

Using the results of the studies described in the previous section, we made a prototype cane with a novel design and ICT support functions. The appearance of Fujitsu's Next-generation Cane is shown in **Figure 4**, and its specifications are listed in **Table 1**.

As a device that connects people and the cloud, the Next-generation Cane can serve as a terminal that provides diverse services (navigation services) via the cloud. It can also sense information (position, number of steps taken, pulse, etc.) about the person using the cane and send that information to the cloud (**Figure 5**). In this way, services can be provided not only to the person using the cane but also to people concerned about the well-being of that person (family, physician, etc.). Fujitsu exhibited the Next-generation Cane at Mobile World Congress 2013, the world's largest mobile-oriented exhibition, where it received much attention as an ICT device having high affinity with the elderly. This event was followed by requests for appearances at a variety of international and domestic exhibitions and on TV programs, which suggested the possibility that our Next-generation Cane would be accepted by society beyond our original expectations.

Moreover, with an eye to expanded use and the provision of next-generation mobility solutions for elderly persons, we have incorporated a link with FUJITSU Intelligent Society Solution SPATIOWL—Fujitsu's location-information cloud service—to provide elderly support through the Next-generation Cane centered about the following three functions (**Figure 6**):

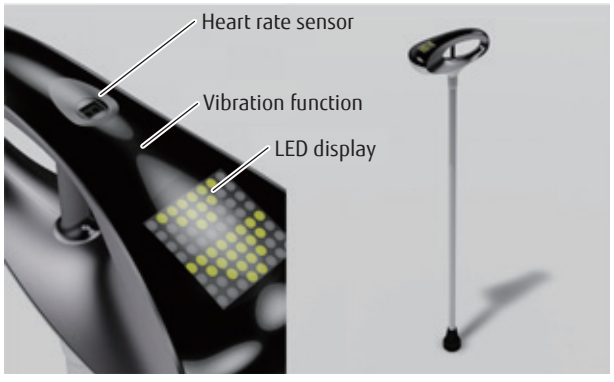

Figure 4
Appearance of Next-generation Cane.

Table 1
Specifications of Next-generation Cane.

Category	Sub-category	Description	Main applications
CPU/ Memory	CPU	Tegra3 AP33 Max 1.5 GHz (quad core)	–
	RAM/ROM	16 GB, 1 GB	–
UI		LED (8×8 matrix)	Display navigation direction and results of heart rate measurements
		Vibrator	Alert user that information is being displayed
Communications		3G	Network connection
		Bluetooth	Network connection, inter-device communication, positioning
		Wi-Fi	
		GPS	Positioning
Sensors	Microcomputer	HCE-LSI V2.1	–
	Sensors	Accelerator	Pedometer
		Gyro	–
		Geomagnetism	Navigation positioning
		Heart rate	Heart rate measurement

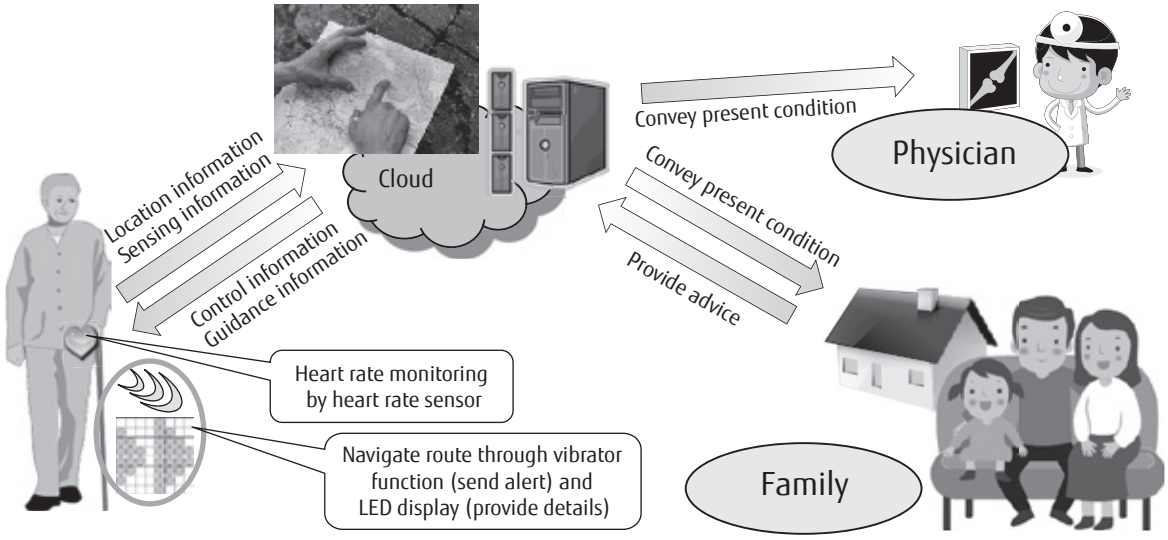

Figure 5
Route navigation and elderly-monitoring services by linking Next-generation Cane to cloud.

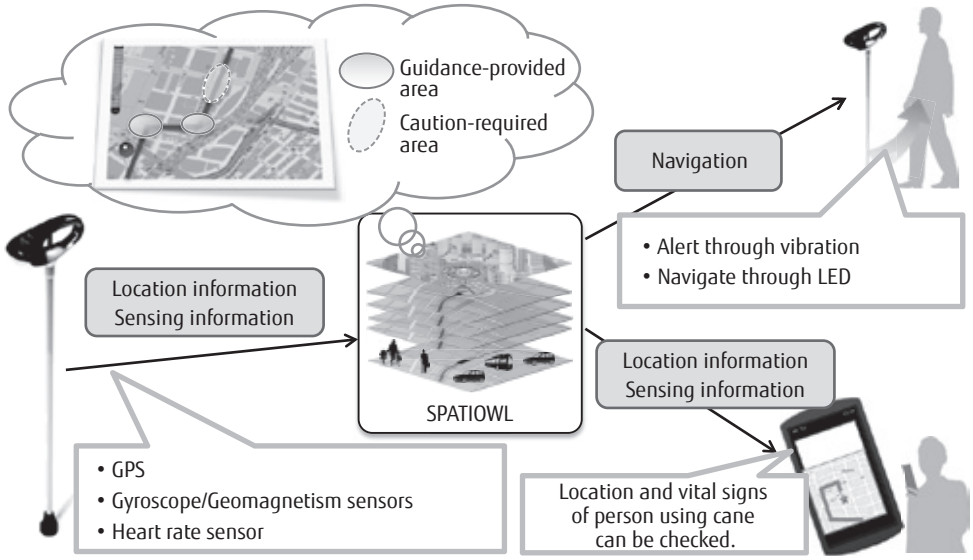

Figure 6
SPATIOWL linking functions.

- Navigation
- Provision of up-to-date road information (alerts about dangerous areas)
- Provision of elderly-monitoring services

4. Conclusion

As shown by our Next-generation Cane, the concept of giving everyday articles ICT functions and a cloud connection and turning them into support tools for everyday living can be applied to a variety of devices. As described here, a user can enjoy added value in the form of security and convenience at just the right time simply by using a cane. Fujitsu's Next-generation Cane enables the user to determine his or her physical condition or state of fatigue through the sensing of vital signs and to receive navigation support that prioritizes roads with fewer bumps or safe roads with less traffic through environmental sensing.

Looking forward, we plan to expand this concept to wearable items by furthering the evolution of people/environment sensing technologies using the HCE-LSI chip and pursuing miniaturization in implementation. Fujitsu is committed to creating new value in the field of wearable computing.

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