Safe, Reliable, Convenient Self-Monitoring Services That Use Wearable Devices

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Abstract

As businesses and entrepreneurs begin to understand the power of IoT to create a dynamic and seamless network of devices interacting behind the scenes, interest in, and demand for, IoT solutions is growing rapidly. The range of IoT solutions is expanding rapidly, encompassing not only quality/operation control, Home Energy Management Systems (HEMS), and security, but also such applications as life care and healthcare, well as autonomous cars and driving support systems. This paper introduces advanced wearable device-based personal IoT solutions (self-monitoring systems) developed by NEC and reviews challenges for the future.

Keywords

IoT, wearable devices, Self-Monitoring Solutions, hearable, biometrics

1. Introduction

The next step in Internet evolution, the Internet of Things (IoT) is upon us, creating an invisible network fabric that allows IoT-enabled products to communicate with one another via the Internet. Organizations and enterprises around the world are rushing to leverage the power of this new technology in fields such as quality control and automation. This trend is propelled by advances in compact design, falling prices for the sensor components needed to capture or monitor the status of "things", massive increases in the speed and capacity of communication lines which have reduced the cost of data transfer, and rapid development of advanced analysis technology that exploits the power of AI.

Leading providers of IoT solutions have already developed and marketed solutions targeted at the manufacturing and energy fields such as quality/operation control, assembly line control, and energy demand prediction, as well as consumer-oriented solutions such as households such as home energy management systems (HEMSs). Currently, they are expanding into life care (mibyo [Chinese medicine-based disease prevention]/health promotion) and healthcare (preventive medicine/early detection), as well as autonomous cars and driving support systems. They are committed to helping achieve IoT-supported health/medical services and autonomous driving functions through industry-academia-government collaboration. They expect to continue to expand IoT into new fields in the future, while innovating ever more sophisticated IoT solutions in otheir existing areas of expertise.

The financial sector, for example, has always been one of the first to recognize the power of new computing and communications technology. "InsurTech", which integrates insurance and technology to generate more dynamic and flexible insurance products, is dramatically reshaping the insurance industry, and a variety of insurance products that take advantage of IoT are already being developed. Health promotion insurance and telematics insurance now offer services that not only discount the insurance charges for customers whose behaviors make them low risk, but also provide tools that encourage the insured to change their perceptions about healthy activity and safe driving. Efforts are also underway to develop solutions that will help customers prevent and avoid risks, as well as to utilize biometrics to help minimize the

burden in the event of an actual occurrence.

Against this background, issues such as protection of privacy are becoming more urgent and more complex. In Japan, for instance, the Amended Act on the Protection of Personal Information was fully enforced as of May 30, 2017. This amendment includes new provisions on how to handle anonymous processing of personal data in order to prevent identification of specific individuals. A number of significant mandatory regulations are now in place that must be followed before anyone can utilize IoT sensor data as big data.

In the following pages, we will look at the personal IoT solutions (self-monitoring systems) NEC is currently developing, discussing not only the wearable devices which collect data at the user end, but also the interaction of these devices with analytic systems in the cloud and the protection of private information.

2. Examples of Wearable Device-Based IoT Solutions

2.1 NEC Wearable Device Functions That will be Incorporated in Our Self-Monitoring Solutions

A wearable device is a generic term for an ICT device that can be carried around by being either on the head, an arm, the body, or a leg. Wearable devices come in a variety of different configurations, including head-mounted displays, smartglasses, smartwatches, accessories, clothing, and even shoes. The Self-Monitoring Solutions currently being developed and tested by NEC use a smartwatch to collect and monitor data.

Sensors incorporated in the smartwatch used for self-monitoring obtain and measure data on the condition of the person wearing the device, as well as the ambient and environmental conditions surrounding the wearer such as pulse, acceleration, temperature, humidity, and location (**Fig. 1**).

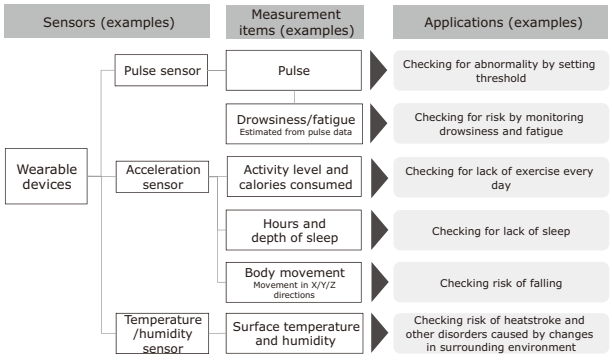

Fig.1 Examples of information that can be obtained by wearable devices.

Using wireless networking (Wi-Fi and Bluetooth), the collected data is transmitted to a server in the cloud via smartphone. Analysis of that data together with other sensor data and system information makes it possible to estimate the wearer's condition at various times.

Once the data has been analyzed, it is also possible to vibrate the smartwatch based on preset rules according to the results. The smartwatch incorporates a vibration on/off function and vibration pattern, duration, and interval adjustment functions that can be combined in various ways to notify the user of multiple items of information. This will enable the device to be used under conditions where the wearer is busy with a task and cannot free their hands or where they do not want to let other people know the notified information.

2.2 The IoT Platform That Supports Our Self-Monitoring Solutions

NEC's Self-Monitoring Solutions will be supported by NEC's IoT platform called "NEC the WISE IoT Platform" (**Fig. 2**).

The "NEC the WISE IoT Platform" will make possible the following: (1) utilization of efficient data collection systems and analysis engines using leading-edge technology such as AI, (2) rapid construction of systems using modular building block structures, and (3) construction of secure and highly robust systems. NEC has leveraged this IoT infrastructure to facilitate the development and expansion of IoT solutions - such as the Self-Monitoring Solutions - for a wide range industries and businesses, as well as public organizations and infrastructure.

2.3 Case Studies

Currently, NEC is conducting validation experiments with customers and in-house testing of our Self-Monitoring Solutions.

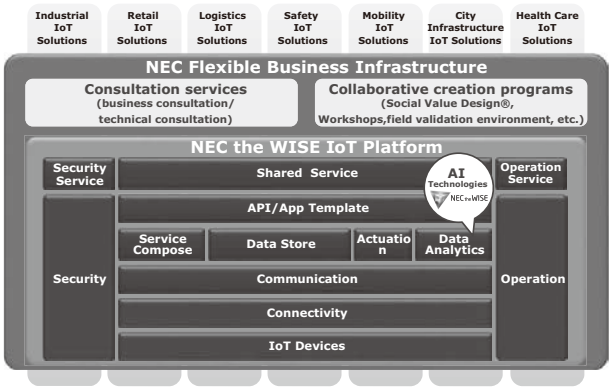

Fig. 2 Configuration of "NEC the WISE IoT Platform."

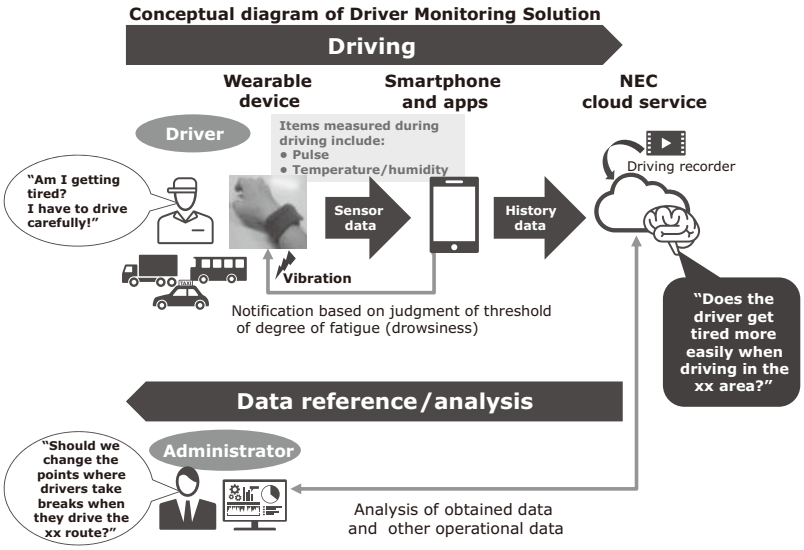

Fig. 3 Conceptual diagram of Driver Monitoring Solution.

(1) Driver Self-Monitoring Solution

This solution is intended for professional taxi, bus, and truck drivers; it detects and notifies the degree of fatigue (drowsiness). When the degree of fatigue (drowsiness) exceeds the pre-specified threshold, a notification (vibration) will be sent to the smart-watch-type device the driver is wearing (**Fig. 3**). This makes it possible for the driver to take a break or do some stretching exercises to refresh themselves so that they can continue to drive safely. Also since the administrator can check the driver's notification history on a webpage, it is possible to design operation management and guidance systems to help prevent accidents - such as enhanced alerts on routes and schedule reviews - by combining the obtained data from the drivers with the drive recorder and GPS information.

(2) Elderly/Care Receiver Self-Monitoring Solution

Targeted at the elderly and people who need nursing care, this solution detects conditions that deviate from normal and notifies families and caregivers (**Fig. 4**). Thanks to the ability to measure sleep conditions, we think this solution will help families and caregivers become aware of any changes in condition at an early stage - even if the care receiver is not aware of any problem. This solution will make it possible for families and caregivers to use their smartphones or PCs to reference information about current conditions with analysis based on comparison between current conditions and past history data. Emails and texts can also be sent to families and caregivers to alert them of conditions that may indicate a problem. In other words, even if families that are far way can easily monitor the condition of an elderly relative or loved one in care.

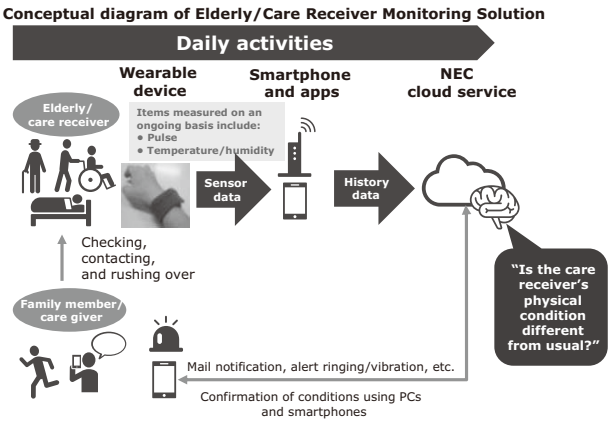

Fig.4 Conceptual diagram of Elderly/Care Receiver Monitoring Solution.

3. Important Points to Consider When Offering Self-Monitoring Solutions

NEC's Self-Monitoring Solutions is a set of value-added services designed to complement the everyday life behavior of the targeted user. This means that the services should be offered in such a way that the user does not experience any discomfort or inconvenience regardless of where or when the services are used. Furthermore, comprehensive security measures are of paramount im-

portance. As the user's personal biological data is being handled, it is essential these services be safe, reliable and secure.

In this section, we will discuss in detail key points that need to be kept in mind when developing and providing Self-Monitoring Solutions.

3.1 Critical Elements of Self-Monitoring Solutions

(1) Timely detection and warning sign alerts

When monitoring such critical conditions as the degree of fatigue of a truck driver or the physiological state of an elderly person or anyone in care, it is imperative to ensure that communications are stable and not subject to any problems that may affect communication with servers in the cloud.

Since the Self-Monitoring Solution is not a medical service, its ability to accurately assess the user's condition is limited. However, it is important that any signs of potential risk be detected and notified in a timely manner.

(2) Free from discomfort or inconvenience in everyday life

The Self-Monitoring Solutions are designed on the assumption that wearable devices are used every day, so it is not only necessary that they be as comfortable to wear as possible, but also that they be as easy to operate as possible. It is also desirable that a selection of devices be available to choose from and that their operation be customizable, and that they be capable of adjusting to specific individual requirements and preferences.

(3) Security measures

The biological data obtained and measured by wearable devices is highly personal and should be considered private. Thus, it is absolutely essential that the collected data be handled with the utmost care and discretion. Smartphones and wearable devices used to collect and transmit self-monitoring data have a high risk of being lost or stolen, so measures must be taken to ensure that the device cannot be misused in the event it is lost or stolen. Moreover, prior to analyzing collected sensor data and other data, data should be masked to prevent the specified individual from being observed.

3.2 Future Prospects of NEC's Self-Monitoring Solutions

(1) Processing of detection and warning sign alerts on edge device where possible

In solutions where real-time risk detection and assured notification are required, we think that the functions should be allocated to the edge device as much as possible (**Fig. 5**). If functions such as detection and warning sign notification are only available on the cloud, there is a risk that they may become unavailable if communications are unstable or are interrupted due to the location or activity of the user. There is also the possibility of temporary processing delays when a failure occurs on the server in the cloud or when loads get too high. For this reason, in our validation testing, we made the service usable anywhere by allocating detection and notification functions to the smartphones used as edge devices.

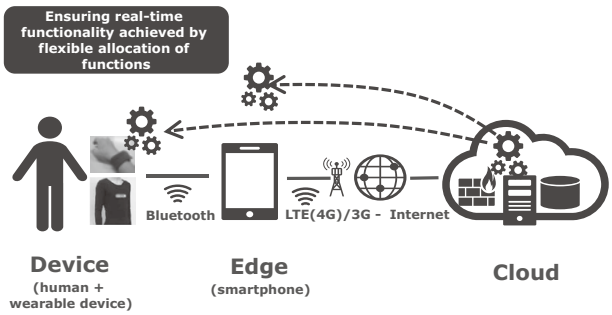

Fig. 5 Allocation of functions in edge devices.

In the meantime, there is limitation in the processing which requires high-level, high-speed edge analysis. Depending on the function being offered, it is important to be able to flexibly determine whether the service should be offered on the edge device or in the cloud.

NEC is now developing edge gateways that will help achieve real-time control using distributed processing, while promoting adoption of container technology that will help achieve flexible and prompt portability. By proceeding with these developmental efforts, we are confident that we will be able to offer Self-Monitoring Solutions that are not restricted by location or time.

(2) Expansion of usable wearable devices

Currently, NEC is conducting research and development of a wearable hearing device that collects personal biological data and sends notifications via voices (**Fig. 6**).

Wearing the device on the ear makes it possible to capture user data and to manage data acquisition and operation without the user having to be conscious of the user interface. We believe that the utilization of hearing devices will enable us to offer new Self-Monitoring Solutions featuring biometric authentication that takes advantage of the ear's acoustic characteristics and location positioning that uses a geomag-

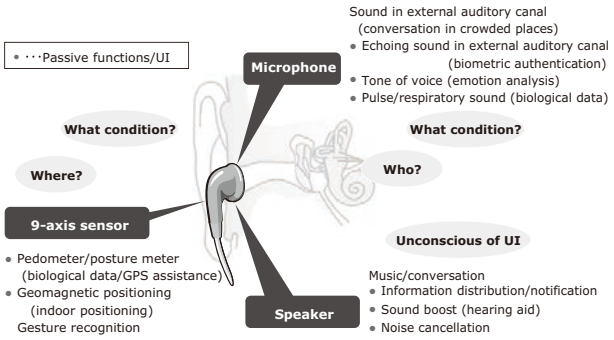

Fig. 6 Features of a hearable device.

netic positioning system that takes advantage of AI and can operate even in locations where GPS cannot be used such as underground and inside buildings.

(3) Enhancement of security measures while ensuring convenience using biometric authentication

Password-free authentication technology using biological data is expected to replace conventional technologies that use IDs and passwords in the near future. Prominent among these new systems is Fast Identity Online (FIDO). The FIDO system securely stores biological data on the client side (smartphone in the Self-Monitoring Solutions) only. No biological data is transmitted to the server in the cloud when authentication is executed. This makes it possible to execute safe online authentication while maintaining privacy. To avoid problems in the event that the FIDO-enabled device is lost, encryption and obfuscation measures are provided in combination with mobile device management (MDM) functions. This maximizes safety and security.

For users, convenience will be improved because they no longer have to enter their IDs and passwords, making authentication a much simpler operation. It also eliminates the risk passwords being forgotten or stolen.

NEC possesses the world's highest level1) of technology in fingerprint and face recognition. We are also performing research and development in various biometric authentication technologies such as finger veins, palmprints, DNA analysis, iris, voiceprints, and the acoustic characteristics of ears. These will be incorporated according to specific requirements in the Self-Monitoring Solutions.

4. Conclusion

NEC will continue to expand the applicable fields of wearable device-based Self-Monitoring Solutions. We are currently investigating systems that use vital sign data to support health management of employees, to manage the daily life of mental health patients, and to communicate with the elderly via hearing devices.

By actively utilizing wearable devices, people will not only be able to capture what is currently happening around them but also predict what will happen in the future earlier and more accurately. At NEC, we are pushing forward with the development of devices that will make it possible to feed the data back to us so that we can adjust our behaviors based on those forecasts. As these solutions become more pervasive and effective, we are confident that they will contribute in immeasurable ways to making people's lives safer and healthier.

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