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Cloud Platform Based Mobile Service for Aging Generation Healthcare Management

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Abstract

The chronic degenerative diseases and physical and mental living difficulties of the aging generation result in low quality of life and the financial burden of medical costs for the government. Better dieting habits affect the aging generation's longevity and health. 54.5% of the aging generation enjoy increased well-being through diet control and diet services. It is necessary to solve the increasing social problem of the aging generation's health. We propose a cloud computing technology-based platform and mobile technology-based services for the aging generation's health management and communication. Elderly people using the mobile service should receive not only diet advice from nutritionists, but also suggestions from doctors and communication with colleagues. A cloud-based mobile diet management service will not only reduce government medical costs but also contribute to public health.

Keywords*: Cloud computing, IaaS, PaaS, personal bio record, health care management*

1. Introduction

According to a National Statistics Office survey from 2012, a quarter of the South Korean population is expected to enter the aging generation (over 65 years old) as of 2020. Thus, this generation's demands for physical and mental health surpass their demands for recent materialistic values [1].

The aging of the population is leading to more chronic diseases and changing the health and social environment. This must overcome the scope of traditional disease-centered health care services provided during patient visits to medical organizations, and personalized medical services are required through management of each patient's daily life [2] and appropriate health interventions [3-4]. The development of mobile technology in particular is changing new medical service environments to mobile health (mHealth) [5-6].

The importance of healthy habits are key in preventing and managing the aging generation's diseases, and practicing healthy habits includes regular exercise, a proper diet, no smoking or drinking alcohol, weight control, *etc.* Diet menu services based on calorie matching and prescription diet services based on questionnaires as well as common dietary restrictions and nutritionist counseling have been provided in recent years. There is also a lot of research regarding personalized diet menu services to prevent lifestyle-related diseases such as diabetes, hypertension, and hyperlipidemia. However, there is a lack of research into personalized fitness services [7].

Therefore, a cloud-based PHR (personal health care record) platform for ISP (information system providers) and several mobile services for aging generation health care management are proposed in this paper.

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Chapter 2 presents related studies on the health/diet management cluster and personalized fitness diet management services for the aging generation. Chapter 3 describes the proposed cloud-based PHR platform and the cloud-based mobile diet management service. System development and experiment results are analyzed in chapter 4. Finally, the conclusion is presented in chapter 5.

2. Related Research

Related research includes research into a health/diet management cluster for the aging generation along with a mobile personalized diet management service. The cluster provides a platform-based mobile application and diet server connection for daily health care services and MD consulting for the aging generation along with online diet menu services. The mobile service provides online communication and health care consultation along with mobile diet menu services.

2.1. Aging Generation Health/Diet Management Cluster

A health/diet management cluster for the aging generation has been implemented in previous studies as shown in Figure 1 [8].

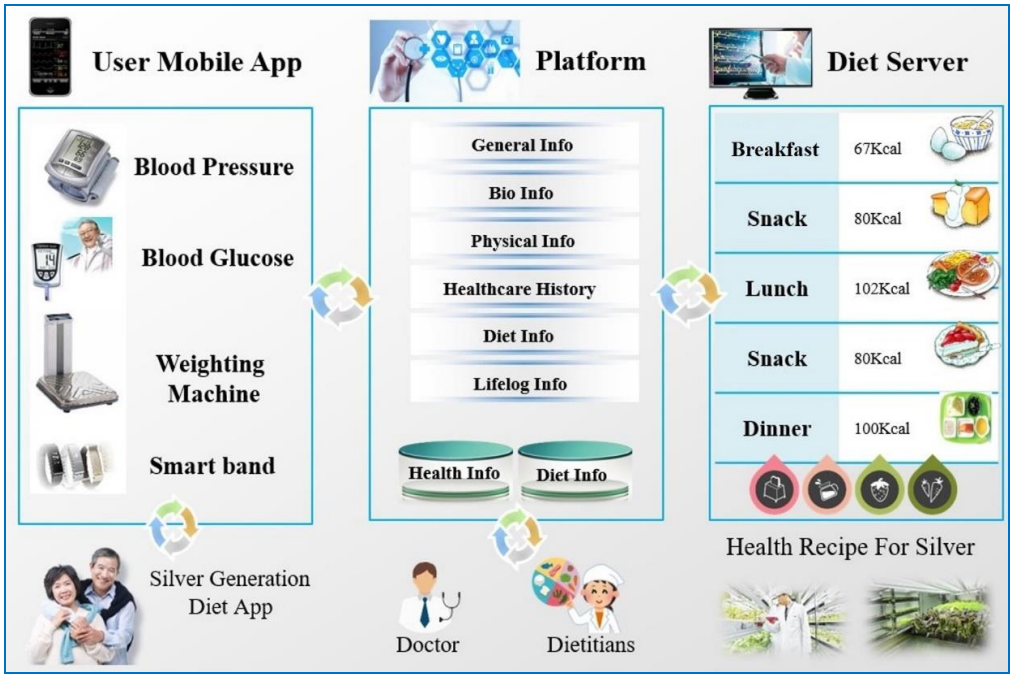


Figure 1. Aging Generation Health/Diet Management Cluster

The diet management cluster for health care for the aging generation comprised two systems, and we proposed a mobile service model based on the cluster using this. The first system is a user PBR (personal biological record)-based platform, and its key features are as follows:

Firstly, it provides connections between daily health care information and a hospital's EMR system. Secondly, the hospital's EMR system manages the user's daily health care information and provides real-time user status monitoring. Thirdly, it provides data analysis and connections for user diet menus. Finally, it provides information standards and private authentication. The second system is a UI- and UX-based user mobile application service, and its key features are as follows:

Firstly, it provides a mobile service for bio inspection results. Secondly, it provides a personalized diet service reflecting nutritionist feedback based on measured health data. Thirdly, it provides a PBR-based aging generation health status monitoring service. Finally, it provides health care communication services for the aging generation.

2.2. Personalized Fitness Diet Management Service

In previous studies we have implemented a diet service for the aging generation as appears in Figure 2 [7].

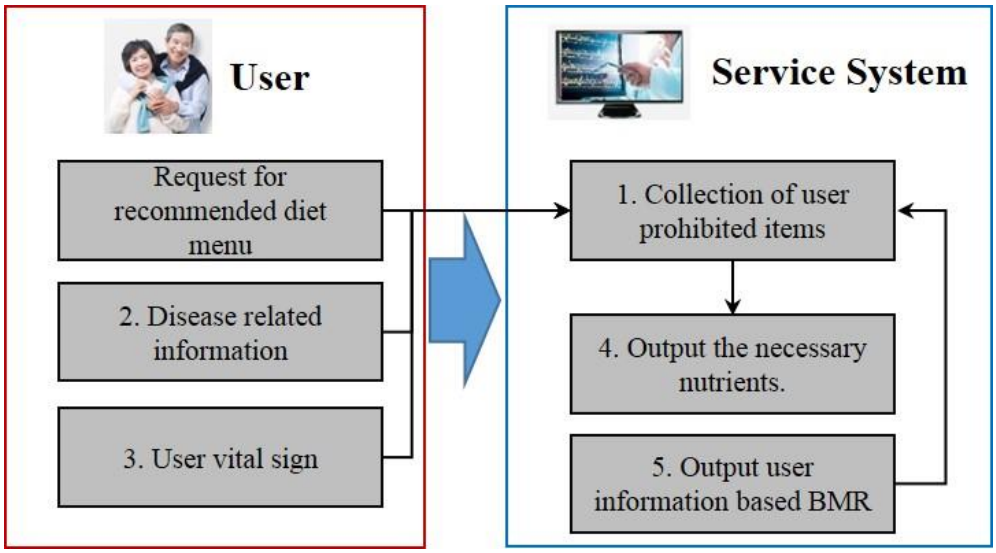


Figure 2. Analysis of Necessary Nutrients

We used the following algorithms to deliver the necessary nutrients.

1) BMR: basal metabolic rate

$$\text{Male } h = 66.4730 + (13.7516 * w) + (5.0033 * s) - (6.7550 * a) \quad (1)$$

$$\text{Female } h = 65.0955 + (9.5634 * w) + (1.8496 * s) - (4.6756 * a) \quad (2)$$

In algorithms (1) and (2), h is the amount of discharged calories, w is weight, s is height, and a represents age.

2) The total of BMR + activity amount equals the necessary nutrients.

$$Nutrient_{Necessary} = BMR + Activity \quad (3)$$

Algorithm (3) is used to derive necessary nutrients based on the user's health information.

3) Preference score

A personalized diet can be provided using a personalized diet model and the user's preferred menus. Preference setting flow is shown in Figure 3. Algorithm (4) was used to calculate a user's preference score when they select their preferred diet menu. The δ refers to increasing or decreasing in this formula.

$$IF_{Prefer} = \frac{1}{2} + atan\frac{\text{atan}(IF_{Basic}) \pm \delta}{\prod/2} / \prod/2 \quad (4)$$

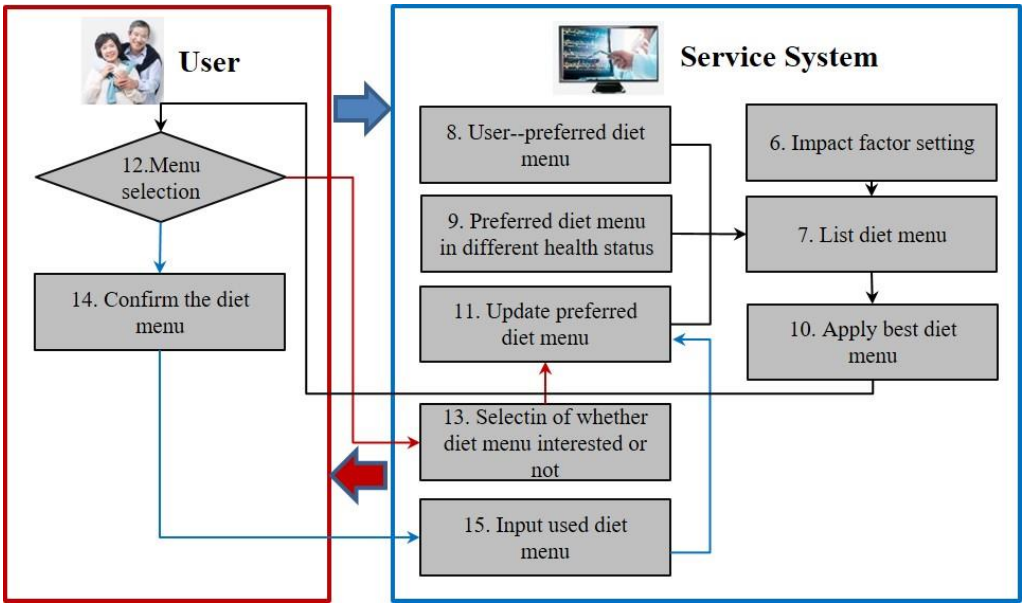


Figure 3. Fitness Diet Menu Recommendation Process

4) Diet menu selection

Diet menus are sorted into several combinations and scored using algorithm (5). In this diet menu service model, menus are offered to suit personalized health management recorded data. Each type of menu is reconstructed according to preference scores, and preference scores for required nutrient lists and health are as shown in Figure 3.

$$SMenu = (1 - \sqrt{([(C - RC)/NC] * 2)}) * 100 * IF\_Prefer \quad (5)$$

5) Personal diet management

Person diet management was measured. Biological records and users' personal health status information as well as family health records were saved in order to analyze current health and predict future health. Additionally, when the service starts, information about the user's personal situation and family health are integrated and used as reference data, and this is analyzed after application to a health prediction model. More accurate and predictive results should be able to be provided since more personal health records are stored.

Optimized diet menus were provided using measured personal biological records and health statuses. This optimized menu was provided through users' preferred diet menus and by monitoring changes in personal health status depending on the applied diet menu. The diet management cluster allows users or doctors to see users' biological records and health information. The cluster provides a graphical view of users' health as well as related details such as medications and diet menu changes.

3. Cloud-Based Mobile Health Care Service

3.1. Cloud-based PHR Platform

The proposed cloud-based PHR (personal health care platform) configuration was as shown in Figure 4. The platform was configured with three components. The first was IaaS (infrastructure as a service), which provides caching, networking and security management as well as system management. The second was PaaS (platform as a service), which provides application development, decision support, web management and streaming. Personal health record analysis is provided in the proposed aging generation health care platform, and application interfaces are provided to various services to offer more convenient UI and UX to users to make a cloud-based online

mobile service for aging generation communication. The third was SaaS (software as a service), which provides CRM (customer relationship management), email, and collaborative service functions. The proposed mobile health care services include a health care application, online doctor consulting application and nutritionist online service application for the aging generation.

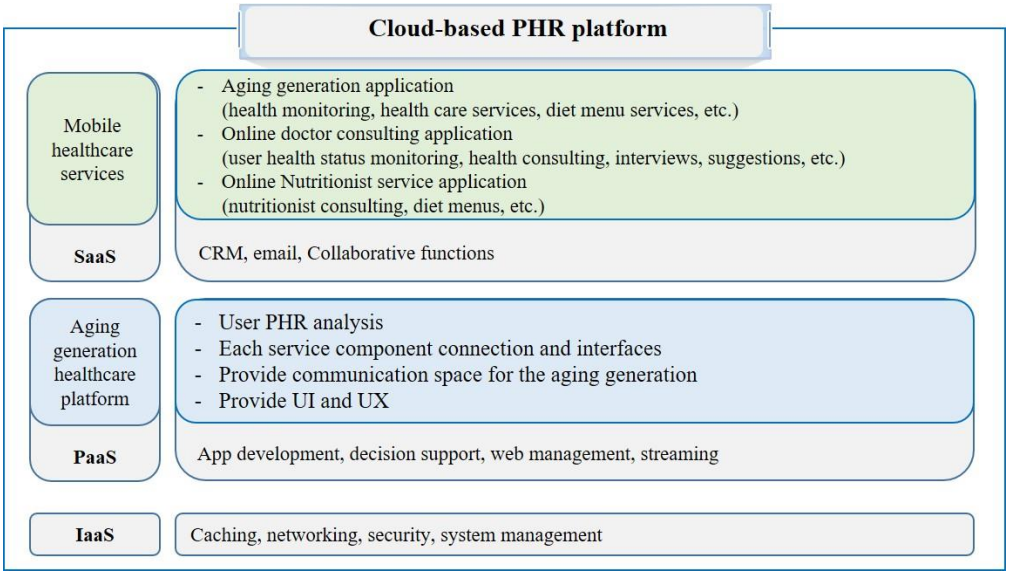


Figure 4. Cloud-Based PHR Platform Configuration

For the goal of building large scale and reliable service and operation scalable infrastructure, we proposed an open source cloud infrastructure configuration as shown in Figure 4. IaaS was configured with five main components. The first was open source cloud computing configuration, providing open source management, virtual server lifecycle management, virtual server creation and deletion, virtual server backup and snapshots, virtual server modification and virtual server termination or resumption services.

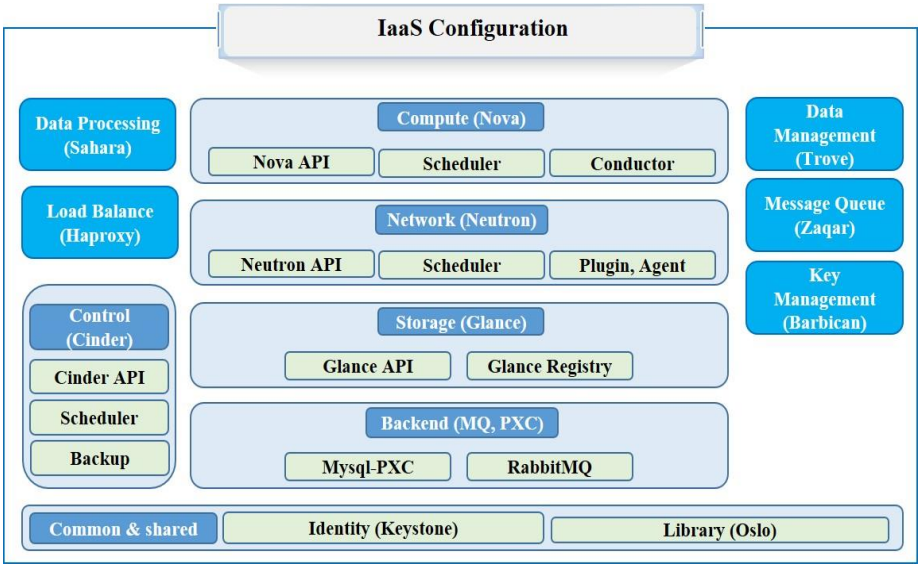


Figure 5. Cloud Infrastructure (IAAS) Configuration

The second one is network configuration, which provides network configuration and development environment, virtual switching creation, and management and load balancing virtualization services. The third was storage configuration, which provides open source configuration for storage, object storage management and block storage management services. The fourth was backend configuration, which provides authentication service, group and template management and automation, target management and virtual server scheduling services. The fifth was control configuration, which provides virtual machine image control, image control logic architecture, and dashboard based image control as well as virtual server scheduling services.

The PaaS was configured with seven main components. The first was platform routing, which provides route discovery and service discovery. The second was authentication, which provides Doppler-based email safety and login server authentication services. The third was application life cycle management, which provides cloud control, network synchronization, Diego brain auctioneer, Diego brain converter and Diego brain metrics server management. The fourth was application execution, which provides Diego cell-based reception and reply, execution, Diego cell garden, application life cycle and Metron management services. The fifth was system monitoring, failure detection and recovery procedures, which provide container or virtual machine failure monitoring and BOSH recovery services, application service status transfer, application fault detection, platform service fault detection, new instance creation and routing table updates monitoring services. The sixth was messaging, which provides BBS and consulting services. The last was log information management, which provides log collection and management for cloud platform collecting and recording of log streams, collection of log information from agent, and the information's storage in the repository. It also applies server log, application log and platform log sorting by the server and services as well as a search service. We proposed a Cloud Foundry-based platform, configured as shown in Figure 5, with the aim of providing development and a framework as well as the common services needed for development.

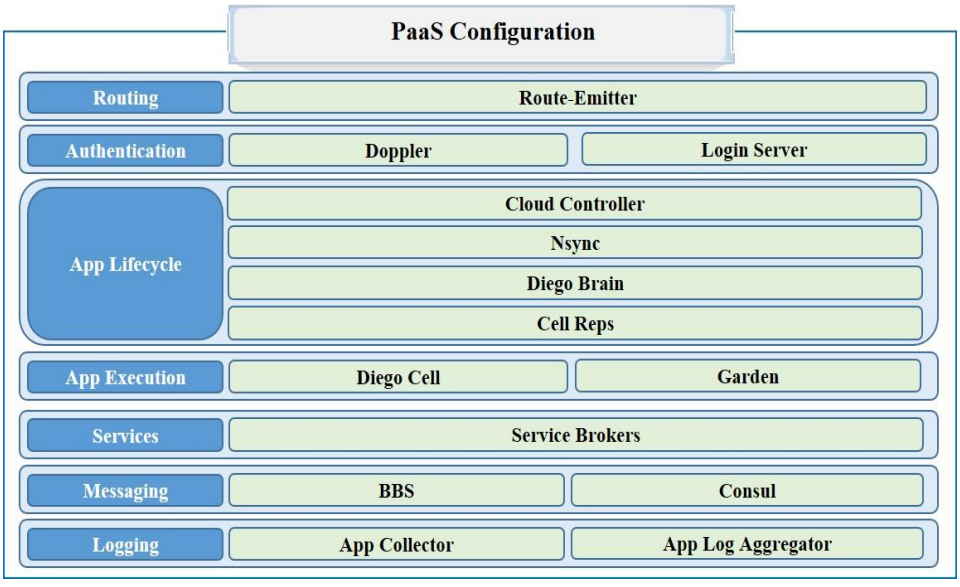


Figure 6. Cloud Platform (PAAS) Configuration

The log collection step includes log collection of each component with Doppler combination and storage in a 3rd party system. When a request is received from a platform user, a search is done in the user view window.

3.2. Cloud-Based Mobile Diet Management Service

The cloud-based mobile diet management service called Cloud PHR includes four main components and provides personal health status monitoring, cyber MD consulting, a fitness diet menu service, and an online communication service.

The personal information monitoring service is shown in Figure 7. When the user inputs personal health information through the mobile user interface, then the health care platform analyzes the user's health and supplies the results to the user. This service not only monitors users' blood pressure, glucose and weight, but also offers daily and weekly user health reports.

Doctor consulting is shown in Figure 8. It is a service to improve the relationship between doctors and patients in which the doctor looks up the health status of registered aging generation users every day and gives advice to the users based on their results and status. When a user makes a specific change, a notification is sent to the patient's smartphone using a push service and the user's personal health status is sent to the cloud platform.

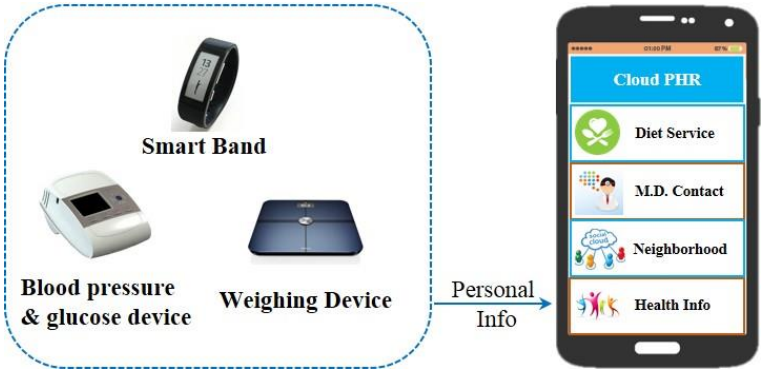


Figure 7. Input Personal Health Information

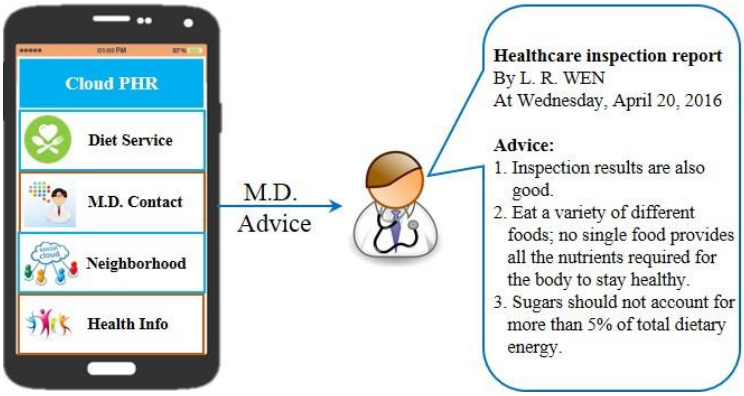


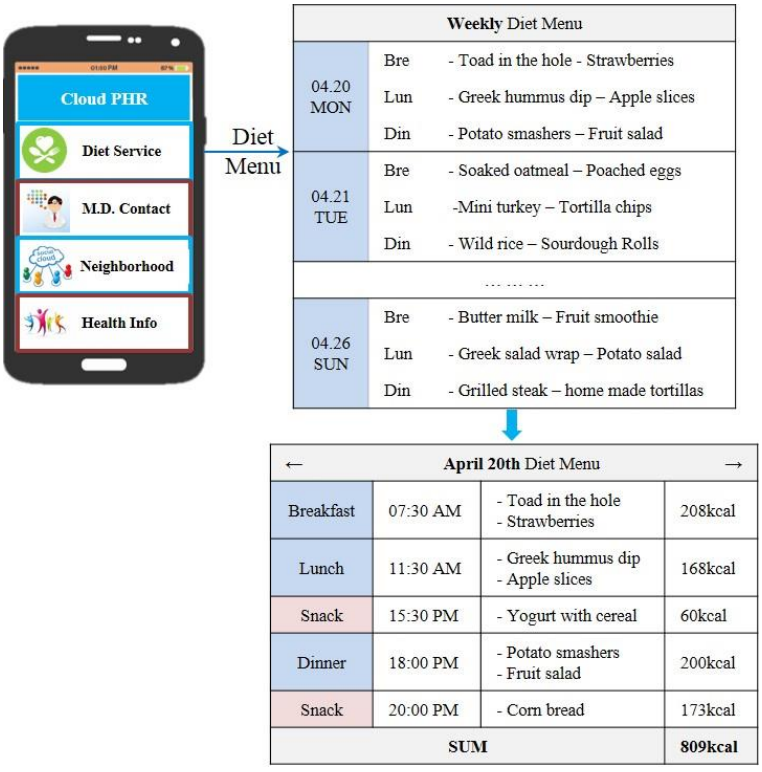
Figure 8. Cloud-Based Health Care Inspection Service

The mobile communication service is shown in Figure 9. The communication service provides the aging generation with services to make friends, search, or chat online with neighbors or friends along with a photo gallery and image sharing. Customers can resolve any problems encountered while using the application using the "Contact Us" service and can connect with their doctors, nutritionist, or friends through the cloud platform.

The mobile aging generation diet menu service is shown in Figure 10. The diet menu service provides healing food information according to the aging generation's health and disease information, and pages to read diet information are also available. Healing foods, diet information, and nutrients entered on the cloud platform by the nutritionist can all be

searched through the mobile application. An important characteristic of the application is that healing foods and diets are offered according to results of monitoring personal health and diseases. This includes a week's worth of diet lists and diets for three daily meals, and healing foods, nutrient information and calorie counts are provided to users at scheduled times. Users of this service can search healing foods and diet lists and order diets from many nutritionists through the platform.

Figure 9. Mobile Communication with Others



Weekly Diet Menu		
04.20 MON	Bre	- Toad in the hole - Strawberries
	Lun	- Greek hummus dip – Apple slices
	Din	- Potato smashers – Fruit salad
04.21 TUE	Bre	- Soaked oatmeal – Poached eggs
	Lun	-Mini turkey – Tortilla chips
	Din	- Wild rice – Sourdough Rolls
... ...		
04.26 SUN	Bre	- Butter milk – Fruit smoothie
	Lun	- Greek salad wrap – Potato salad
	Din	- Grilled steak – home made tortillas

← **April 20th** Diet Menu →			
Breakfast	07:30 AM	- Toad in the hole - Strawberries	208kcal
Lunch	11:30 AM	- Greek hummus dip - Apple slices	168kcal
Snack	15:30 PM	- Yogurt with cereal	60kcal
Dinner	18:00 PM	- Potato smashers - Fruit salad	200kcal
Snack	20:00 PM	- Corn bread	173kcal
SUM			**809kcal**

Figure 10. Cloud-Based Diet Menu Service

4. Implementation and Evaluation

Effects of implementing the system are shown in Figure 11. The cloud-based platform provides an API to allow a service for the aging generation, nutritionists, and doctors, infrastructure API for the personal health care platform and mobile service management, and developer API for application modification and updates as well as for backup management. The platform provides a framework for service development and big data management of users' biological records and health care records as well as network authentication for personal security and mobile device security.

The cloud-based platform is classified into three layers. The first layer, IaaS, provides computing, data storage, networking, and security and supports the backend. The second layer, PaaS, provides routing and authentication services, application control services, service control, and log management services. The third layer, SaaS, provides personalized diet menus, MD consulting, and online communication services. For user security, we implemented personal information and code security services. Extended services include public service for health care content, a personal health care prediction service based on big data analysis, and personal health care status and disease messaging services.

One key technology is connection with mobile along with cloud management, and another key technology is standardization of personal health management information.

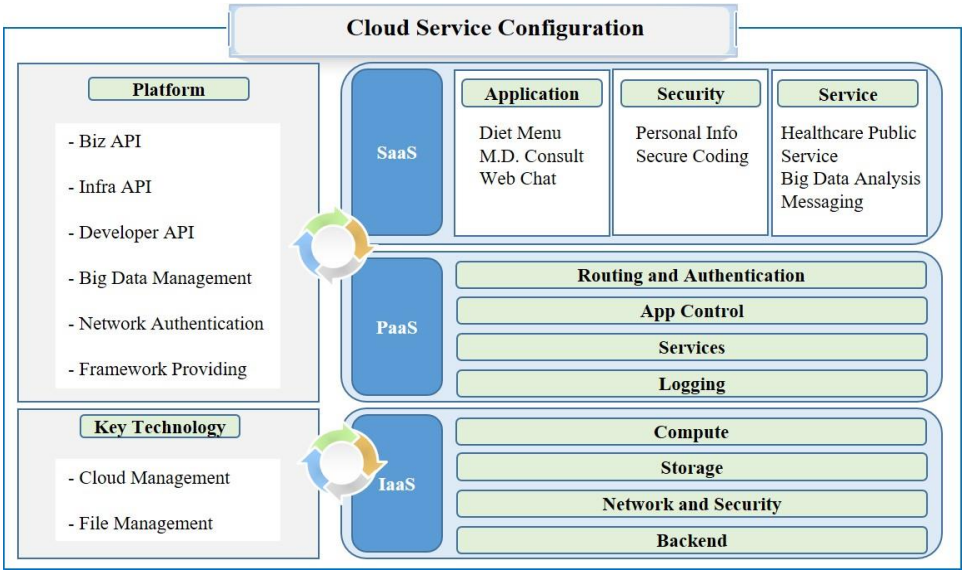


Figure 11. Effects of System Implementation

5. Conclusion

In this paper, we proposed a cloud-based mobile service for health care management for the aging generation. The proposed service model will lead to progress in three respects:

Technologically, with the development of mobile applications and smartphone penetration, more generations are using smartphones, and various services along with sensor devices and applications are being developed. Current smartphones are even loaded with heartbeat sensors and high-performance cameras, and health care apps using these sensors will influence the development of various services suited for the aging generation. The development of services suitable for the aging generation means that related technology will spread with the development and diffusion of exclusive sensors and applications.

Economically, disease prevention and aftercare for health care management of the aging generation should reduce government medical costs. Expert doctors and nutritionists can provide diets to the aging generation through the cloud platform along with health consulting services.

Socially, the service should expand health care services via dramatically increasing use of mobile devices and should provide stable social and political effects.

With this proposed mobile diet management service model, it is expected that the aging generation will enjoy better health and fitness services.

Acknowledgments

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