

## Design of Diet Recommendation System for Healthcare Service Based on User Information

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**Abstract**— In the recent aging society, studies on health care services have been actively conducted to provide quality services to medical consumers in wire and wireless environments. However, there are some problems in these health care services due to the lack of personalized service and the uniformed way in services. For solving these issues, studies on customized services in medical markets have been processed. However, because a diet recommendation service is only focused on the personal disease information, it is difficult to provide specific customized services to users. This study provides a customized diet recommendation service for preventing and managing coronary heart disease in health care services. This service provides a customized diet to customers by considering the basic information, vital sign, family history of diseases, food preferences according to seasons and intakes for the customers who are concerning about the coronary heart disease. The users who receive this service can use a customized diet service differed from the conventional service and that supports continuous services and helps changes in customers living habits.

**Keywords**—Healthcare; Diet Recommendation; Preference

### I. INTRODUCTION

In recent years, life and dietary styles in Korea have been largely changed according to rapid changes in economic situations. In addition, diseases caused by the changed life style, such as fatness, cardiovascular disease, diabetes, and hypertension, have been significantly increased [1][2].

In the case of the cardiovascular disease, it is difficult to treat as a complete cure as it occurs and brings some complications. Therefore, it will be a charge on users and families in economical and caring aspects. Thus, the importance of the primary prevention for diseases that controls such a disease itself has been emphasized.

Because the cardiovascular disease is not caused by the heart itself but is largely due to the complications, such as hypertension, diabetes, fatness, and other diseases, the importance of the carrying of a healthy life style like regular

exercise, right dietary habit, stop smoking, abstain from drinking, and weight control has also been emphasized. In recent years, studies on the diet related to life style caused diseases, such as diabetes, hypertension, and hyperlipidemia, in the viewpoint of a manager who prescribes specific dietary sets based on the database through general dietary constrains from medical specialists, nutritionist counseling or questionnaires, and calorie table have been largely conducted. However, there are few personalized diets and services for users.

This study proposes a personalization diet recommended service for the users who require the prevention and management for coronary heart disease. This service consists of a collection module that draws nutrients, which are to be adopted by users based on the collection of some constraints in users, a configuration module that determines the preference of foods through the input of the diet of users, and a scoring module that makes a score for the extractable diet. In addition, based on the service, it is possible to receive a recommendation of various and customized diets according to the present disease history, family history, personal information, amount of activity, and preference of users. Also, it helps to prevent such a coronary heart disease in a home easily.

### II. DIET RECOMMENDATION SERVICES

A diet recommendation service provides specific foods that help to release a state in nutritional unbalance by analyzing the nutrition condition in each person. The existing diet recommendation service can be summarized as following three different types.

First, in the method that considers the general constraint in diets by some medical specialists, it prescribes the items that are to be avoided in the diet recommended by doctors. It

only provides the constraint related to diseases and that may present some disadvantages in which this method does not consider the active attitude of users because it is a passive diet prescription for users that does not consider the seriousness of diseases [3].

Second, in the method that prescribes the diet through nutritionist counseling or questionnaires, it finds the dietary habit of patients based on the information obtained from various questions and prescribes the diet by comparing the reference table of nutrition. It is a method that uses the reference table of nutrition through regarding the preference of patients using questionnaires. Although this method is able to provide personalization diet recommended services for users compared to that of the conventional system, it is not enough to apply the personalization diet recommended services for users because it does not consider the various conditions in users' diet, intake level, diet, and exercise in a short period of time [4].

Finally, in the method that prescribes a specific diet set based on the database presented by a calorie table, it provides the diet list recommended by doctors or nutritionists as a type of database. However, this method represents a limitation that cannot provide personalized services because it prescribes the diet that is to be implemented by users without considering any variety in [5].

Therefore, this study proposes a new personalization diet recommended service through considering the real-time vital sign, family history, food preference, and intake of users in order to solve the limitation in the existing diet recommendation services.

### III. DIET RECOMMENDATION BASED ON REQUIRED NUTRIENTS AND FOOD PREFERENCE

The personalization diet recommended service (PDRS) proposed in this study is a specific service that recommends a proper and personalized diet to the persons who concern the coronary heart disease.

#### A. Nutrient Extraction Module

The required nutrient extraction module is a part that collects the disease management condition, real-time vital sign, and BMR information of users in order to configure the impact factor for recommending a personalized diet for users.

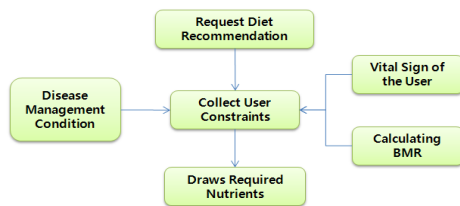


Figure 1. Required Nutrients Draw

As shown in Fig. 1, if a user requests diet recommendation, the system receives the disease management condition and vital sign of the user in real-time and collects user constraints through calculating BMR. Then, it draws the required nutrients using the collected information. (1) is an equation that extracts the BMR where  $h$  is the amount of calorie discharge (Kcal) for 24 hours,  $w$  is weight (kg),  $s$  is height (cm), and  $a$  represents age.

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

$$h(\text{Female}) = 65.0955 + (9.5634 \cdot w) + (1.8496 \cdot s) - (4.6756 \cdot a) \quad (1)$$

(2) shows an equation that draws the required nutrients.

$$\text{RN(Required Nutrients)} = \text{BMR} + \text{Activities} \quad (2)$$

It is an algorithm that collects user constraints (family history and blood pressure of the vital sign of users) and draws the nutrients, which are to be intake by users, based on the collected data. Also, it stores the disease condition of users to DB including the presence of family history and its degrees and obtains some factors, such as blood pressure, pulsation, and blood sugar level, from sensors (direct input or wire/wireless input using heterogeneous sensors through a proper user interface) in order to verify the present health condition of users. In addition, it extracts BMR by considering the weight, height, and existing input data (sex, age, and others). Also, the required nutrients can be obtained by summing the BMR (basal metabolic rate) and activities.

For instance, in case of a 27 years old female with the height and weight of 160cm and 47kg who shows hypertension due to the family history and consumes 1000Kcal per day, she should intake the nutrients of 2274.27 as daily required nutrients by adding the activity of 1000 to the BMR of 1274.27.

#### B. Preference Configuration Module

The preference configuration module helps to provide a personalized diet to users by considering the preferred foods of users. It is determined by the preference according to the preference configuration and environment by inputting the intake diet of users.

The preference configuration through the input of the intake diet of users can be updated by the direct selection of the diet information recommended to users. If users select the recommended diet, the system will increase the preference for each diet by reflecting the content of the diet. If the diet is selected as a unpreference item by users, the system will decrease the preference for each diet and that provides a low score in a diet scoring process.

### IV. DESIGN OF A DIET RECOMMENDATION SYSTEM

A personalized diet recommendation system transfers various vital signs measured from a home to a specific server and provides a function that controls the diet in order to prevent diseases and manage the diet by examining the

health condition of users based on these vital signs and personal information.

In the system architecture represented in Fig. 2, the data obtained from various sensors, which are applied to measure vital signs, is transferred to a server through the Vital Sign Standard Agent installed in a home. This Agent performs a process that transforms the vital signs into a standardized XML format before transmitting the vital signs measured from heterogeneous sensors to a server.

The Vital Data Recorder that receives the XML Data records the signs to the Database, and the accumulated data is to recommend a proper diet by evaluating the health condition of users through the analysis and estimation of the data.

In addition, a clinician or user is able to query the health condition or change in vital signs through the Request Agent.

The Diet Management analyzes the present condition of a subject based on the measured and accumulated Vital Data, personal information of users, and family history and estimates the future health condition. In addition, the initial stage of the system that shows a lack in measured data performs the estimation using the basic information, such as personal information and family history, and estimation model, and then it can perform the estimation using a more accurate estimation model using the accumulated data. Then, it can provide an optimized diet for users by considering the measured vital signs and the health condition of users. Furthermore, it is possible to provide a diet according to the diet course (maintaining health, reinforcing physical strength, and seasonal foods) that is preferred by users and plays a role in the observation of the change in vital signs according to the diet. If the vital signs are changed as an abnormal symptom in health, the diet should be changed.

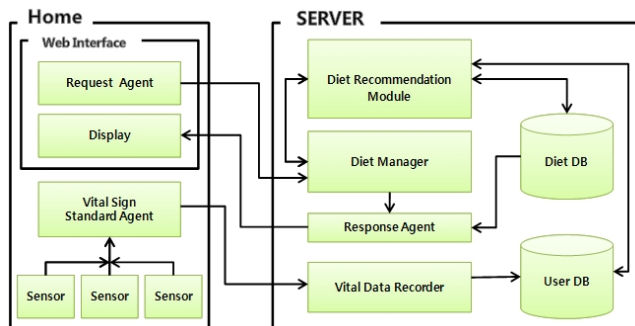


Figure 2. Diet Recommendation System Architecture

Fig. 2 Architecture of a personalized diet recommendation system

The Request Agent provides a function that can query the vital signs or health indexes of users by user themselves or doctors. It presents the change in vital signs and health indexes to a monitor as tables or graphs in which if a user selects a specific area in the monitor, it will provide more detailed information on prescriptions and changes in the diet recommendation. The existing diet recommendation service is a passive service that recommends a diet list using the

general information on diseases only. However, this study proposes a personalized diet recommendation service by generalizing the health condition, activities, preferred foods, and intake content of users in order to solve the disadvantages and problems existed in the conventional recommendation services.

## V. CONCLUSIONS

This service is possible to recommend a specific diet by observing the daily nutrition condition of users and manage the general vital signs of users using a vital sign indicator. Then, it provides the diet recommendation as a daily service. It means that the service helps to prevent and manage diseases by recommending a personalized diet for users.

The personalization diet recommendation service proposes a diet therapy, which is a type of non pharmacological treatment, instead of using pharmacological treatments in order to prevent the coronary heart disease and that helps to prevent and manage the disease easily. Also, users can receive the recommendation of various diets by considering the preference of foods of users.

For future studies, this study will develop the context recognition middleware for the management of health that obtains the activity and information of diet patterns (meal time, number of meals, and amount of meals) of users. In addition, the developed middleware can provide the analyzed information for a diet recommendation service and that is expected to provide an automated and personalized diet list to users.

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## REFERENCES

- [1] ChoiYS, ChoSH, SeiJM, LeeNH, ParkWH, SongKE, "Effectiveness of nutrition counseling on dietary behavior and serum levels of lipids and antioxidant in patients with cardiovascular disease" *KorJNtr* 32(6): 681-690, 1999
- [2] LeeMS, "Relationship of there lative risks of the me tabolic syndrome and dietary habits of middle-aged in seoul" *Korean J Comm Ntr*9(6):695-705, 2004
- [3] <http://www.goliving.co.kr/prevention>
- [4] <http://www.hidoc.co.kr/HealthPedia>
- [5] <http://neps.welltizen.com/home/index.asp>
- [6] NicolosiRJ, WilsonTA, LawtonC, Hande lman GJ. "Dietary effect son cardiovascular disease risk factors: Beyond saturated fatty acids and cholesterol." *JAm CollNtr* 20(5): 421-427, 2001
- [7] [19] IgnarroLJ, BalestrieriML, NapoliC. " Nutrition, physicalactivity,and cardiovascular disease: An update." *CardiovascRes* , 2006
- [8] [20] Voutilainen S,NurmiT,Mursu J,Rossanen TH. "Carotenoids and cardiovascular health." *Am JClinNtr*83:1265-1271, 2006
- [9] D. Beckett, "RDF/XML Syntax Specificati-on," W3C, 2004.
- [10] WHO. "Diet, nutrition and the prevention of chronic diseases." WHO Technical Report Series;916.Geneva 81-94, 2003