DietTalk: Diet and Health Assistant Based on Spoken Dialog System

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Abstract. This paper presents DietTalk, a diet and health assistant based on a spoken dialog system. The purpose of DietTalk is to help people to control their weight by consulting with it using natural language. DietTalk stores personal status, provides food and exercise information, and recommends appropriate food and exercise. To evaluate the effectiveness of DietTalk, we performed human user experiments. DietTalk had good accuracy and satisfied users; therefore.

Keywords: natural language, recommendation system

1 Introduction

Many people intake an unbalanced diet or do not get sufficient exercise, so they have difficulty in achieving diet and health goals. Computer-assisted food and exercise management can help those people. A previous study proposed application software for diet and health management [1], but provided only a touch user interface; a dialog interface can provide better accessibility and user experience for users than can a touch interface. Due to recent advances in natural language processing technology, spoken dialog systems (SDSs) are now widely used to provide dialog interfaces [2, 3].

In this paper, we propose DietTalk, which is a diet and health assistant based on SDS. DietTalk consists of a dialog agent (DA) and a service agent (SA) (Fig. 1). The DA understands requests, manages dialog, and generates responses. Based on the decision of the DA, the SA performs service functions including management of personal status, offering of information on health and diet, recommendation of food menu, and recommendation of exercises. We proposed the concept of DietTalk in The REAL Challenge Workshop[1].

[1]https://dialrc.org/realchallenge/

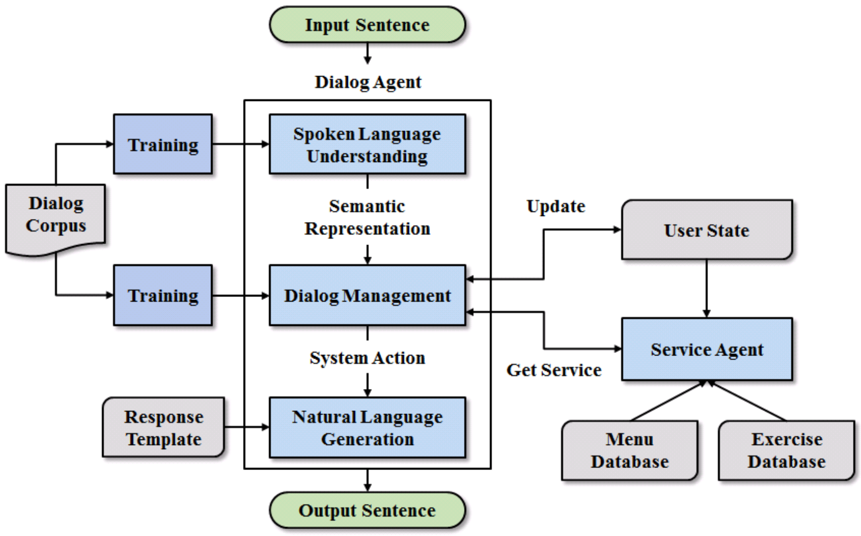

Fig. 1. System architecture of diet and health assistant based on spoken dialog system.

The rest of the paper is organized as follows: Section 2 describes the DA in detail. Section 3 describes the SA in detail. Section 4 demonstrates the evaluation design and results. Finally, Section 5 draws conclusions.

2 Dialog Agent

DA consists of three sequential processes: spoken language understanding (SLU), dialog management (DM), and natural language generation (NLG). In SLU, a machine-readable semantic frame is automatically extracted from a natural language sentence. We defined a semantic frame to be a combination of intent and named entities. To determine intent we used maximum entropy [4], and to recognize named entities we used conditional random fields [5].

In DM, a system action is automatically chosen based on the dialog state and the extracted semantic frame. To determine a system action, we used the example-based dialog management (EBDM) technique [3]. In EBDM, given the dialog state and the extracted semantic frame, the semantically-closest example is retrieved from a dialog example database. Afterwards, the system action attached to the dialog example is chosen as the output of the DM.

In NLG, a natural language response is automatically generated based on the chosen system action. To generate a natural language response, we used a simple template-based approach [3]. A sentence template is first selected from the system action, then the blanks are filled in with the parameters of the chosen action.

3 Service Agent

The SA performs a designated service and returns the service execution results. We implemented many service functions related to health and diet:

1) storing personal physical status (age, sex, height, and weight),
2) storing personal preferences on food and exercise,
3) storing desired weight,
4) offering information on health and diet,
5) recommending food menu,
6) recommending exercise.

In the rest of this section, we introduce the methods for recommending food menu and exercise.

3.1Food Menu Recommendation

The SA uses four scores on a scale of 0 to 100 to evaluate a food menu *M*.

1) $Score_{calorie}(M)$: closeness between total calories of *M* and adequate calories for the user's meal. A high score means that *M* provides appropriate calories.
2) $Score_{pref}(M, U)$: agreement between *M* and the stored preferences of the *U*. A high score means that *M* meets the *U*'s preferences.
3) $Score_{comb}(M)$: the naturalness of *M*. We compute a combination score based on food category. A high score means that the combination of food items is natural for a human.
4) $Score_{rand}$: random score. This score allows users to receive various food recommendations even in the same situation.

The total score is the weighted sum of scores 1 - 4. To broaden user's choices, we designed three food menus. The SA recommends the food menu that has the maximum score in each type.

A type-1 menu consists of a single meal. The total score of this menu is computed as:

$$0.75 \times Score_{calorie}(M) + 0.15 \times Score_{pref}(M,U) + 0.1 \times Score_{rand}. \quad (1)$$

A type-2-menu consists of a meal and a drink; a type-3-menu is a Korean meal that consists of rice, soup, and two side dishes. Total scores of type-2 and type-3-menus are computed as

$$0.65 \times Score_{calorie}(M) + 0.15 \times Score_{pref}(M,U) + 0.1 \times Score_{comb}(M) + 0.1 \times Score_{rand}. \quad (2)$$

The food menu database was modified from a previous study [1].

3.2 Exercise Recommendation

To maximize the efficiency of calorie expenditure, the SA recommends Exercise (*E*) as combination of anaerobic and aerobic exercise.

1) $Calorie_{today\_exercise}(E)$: the calories which remain to be burned by exercise today. It considers $Calorie_{remain}(E)$ and $Calorie_{diet}(E)$. A high value means that the user has to exercise for much of the day.
2) $Calorie_{remain}(E)$: the difference between today's suggested calories and food calories which the user has eaten to the time of assessment. A high value means that the user did not eat many calories. A negative number means that the user has already exceeded today's suggested calorie intake.
3) $Calorie_{diet}(E)$: the number of calories to be burned to achieve the desired weight during the period set by the user. This variable considers current weight, goal weight, and the time (months) that the user has chosen as the period over which to lose the target amount of weight. A high value means that the user wants to lose a large amount of weight in a short time.

To lose 1 kg, the user must burn 7700 kcal more than he or she eats. Therefore, if current weight exceeds target weight, then based on $Calorie_{today\_exercise}(E)$, DietTalk chooses appropriate exercises from an exercise database. Calories that the user will burn by exercise are calculated as

$$Calorie_{diet}(E) = \frac{(Current\ weight - Goal\ weight) \times 7700\ kcal}{User - specicied\ diet\ duration}. \quad (3)$$

$$Calorie_{today\_exercise}(E) = Calorie_{diet}(E) - Calorie_{remain}(E). \quad (4)$$

We built the exercise database from various web pages about exercise.

4 Evaluation

4.1 Experimental Designs

To train SLU and the DM, we collected a Korean-language dialog corpus for the DietTalk domain. The corpus consists of 559 pairs of user utterance and system utterance. We annotated semantic information including intents (n = 49) and named entities (n = 17) onto each sentence.

To evaluate DietTalk, we performed human user experiments. We asked five student volunteers to complete five dialog tasks, then measured task completion rate (TCR), successful turn rate (STR), and average dialog length (ADL). We also asked the volunteers to complete a questionnaire.

4.2 Experimental Results

Table 1. Evaluated performance of DietTalk.

Task completion rate	Successful turn rate	Average dialog length
0.84	0.81	8.80

DietTalk achieved TCR = 0.84, STR = 0.81, and ADL = 8.80 (Table 1). This result indicates that DietTalk provided an accurate dialog interface to the volunteers.

Before using DietTalk, all volunteers had high interest in weight control, but were only moderately (5.6/10) satisfied with their weight control (Table 2). After using DietTalk, some volunteers pointed out that the naturalness of dialog was insufficient (Table 3). However, all volunteers were satisfied with the effectiveness of DietTalk for weight control (Table 3).

Table 2. Users' questionnaires for DietTalk on a scale of 1 to 10.

Questions	Mean	s.d.
Pre-test		
Do you have interest in weight control?	7.60	1.02
Do you fulfill your weight control compared to your interest?	5.60	1.62
Post-test		
Was your conversation with DietTalk natural?	7.20	2.14
Are you satisfied with the response time of DietTalk?	7.80	1.47
Do you think DietTalk is useful for weight control?	8.40	1.36
Will you recommend DietTalk to friends?	8.00	1.10

Table 3. A translated example of dialog with DietTalk.

	Beginning of dialog
User	My height is 175 cm and weight is 65 kg.
System	Yes. I stored this information. (height: 175 cm, weight: 65 kg)
User	What is my BMI index?
System	Your BMI index is 21.22, and it is normal.
	At lunch time
User	How many calories are there in a slice of pizza?
System	A slice of pizza is 403.5 kcal.
User	Then I will eat whopper burger in lunch.
System	You ate whopper burger. OK.
	At dinner time
User	What shall I have for dinner?
System	How about a bowl of Bibimbap and a cup of Sikhye?
	After having dinner
User	Recommend exercise, please.
System	Today, what about do sideband dumb-bell and basketball 12 minutes?
User	Exercise is too tiring.
System	Cheer up!

5 Conclusion

In this paper, we proposed DietTalk, which is a diet and health assistant based on SDS technology. DietTalk consists of a DA and a SA. The dialog understands requests, manages dialog, and generates responses. The SA performs various service functions. DietTalk can provide personalized diet and health assistance service to users. In experiments, DietTalk had good accuracy and satisfied users; therefore.

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