Smartphone-Based Self Management System for Type-2 Diabetes Patients

Eiji Aramaki, PhD; Mai Miyabe, PhD; Kayo Waki, MD, MPH, PhD; Hideo Fujita, MD, PhD; Yuji Uchimura, DDS; Koji Omae, MBA; Masayo Hayakawa, MPH; Takashi Kadowaki, MD, PhD; Kazuhiko Ohe, MD, PhD

The University of Tokyo eiji.aramaki@gmail.com

Abstract

This paper proposes a novel telemedicine system for type 2 diabetes patients. The proposed system supports the patient self-management via a set of telemedicine devices, consisting of health sensors and a smart phone. The proposed system covers not only the sensor data but also the diet (food) and exercise data. To capture the food information, we also developed the voice recognition module focusing on the food names. The basic feasibility of the system is practically demonstrated in the preliminary experiment.

Introduction

Nowadays, the ubiquitous computing technology (such as Wi-Fi, Bluetooth, and IC tag technologies) improves year by year. This trend naturally encourages developing various smart health devices. The example is shown in Figure 1. The device could measure the blood pressures, and the values could be sent to a PC via Bluetooth.

Due to the device improvement, the effectiveness of the self-health management draws much attention. Especially, it could be promising for several chronic diseases, which requires careful health control.

In such a situation, we are challenging to develop semi-automatic health control system for type-2 diabetic patients. For diabetic patient, it is fatal to control blood glucose. To do so, it is important to improve their life style habits, including food or exercise control.

To realize the health control system, the following three core technologies are essential:

(1) Numerous data analysis: The method for analyzing the quantitative data, such as body weight, blood pressure and so on.

Figure 1: A blood pressure meter with Bluetooth

(2) Text data analysis: The method for analyzing the qualitative data, such as diet food data and exercise data.

(3) Communication module: The method for combining both numerous data and text data, and generate a suitable advice to the patient.

Among the above three technologies, the first one is relatively easy, because numerous data is easy to handle. In contrast, the other parts are challenging, because it have to handle text data. To realize precise well performance, deep Natural Language Processing (NLP) techniques are required.

This paper mainly focuses on the NLP techniques for the proposed system.

System

System Configuration

This proposed system, DialBetics, consists of (1) a set-of health devices that measures patient numerous data, and

(2) a smartphone that captures the diet and exercise information (text information), and (3) a server that gathers patient data, and reply advice (Figure 2).

(1) Numerous Data analysis: Patients' numerous data, measured at home, are sent to the server twice daily via Bluetooth. The data consists of body weight, blood pressure, and blood glucose. Transmitted data are automatically evaluated by the Japan Diabetes Society guideline. The evaluated value is presented to the patient for the self-monitoring (Figure 3).

(2) **Text data analysis:** For gathering the food and exercise information, we developed the two types of input methods:

Voice-based input: Using the voice recognition API, the patient's voice message is analyzed.

Short Message-based input: Using the key typing input.

The input food is classified into 3,000 food categories. The food data example is shown in Figure 4.

(3) Communication Module:

The system sends a suitable message corresponding to the patient data. To do so, we developed the advice database. The database consists of the pair of the patient food situation and the advice. The example is shown in Table 1. Then, the system selects the suitable message, corresponding to the patient situation.

Voice Recognition Method

To realize the system, the core technique is how to process the text data from patient. Because text data contains the various orthographic ambiguities, there is a gap between the patient input and the database. For example, "a sea food spaghetti" also called as follows: "a sea food pasta", "pasta of sea food", "seafood pasta", or "squid and shrimp spaghetti" etc. It is extremely heavy task for the database to cover such various expressions.

To reduce the burden of the task, we employed NLP based disambiguate system. The proposed system classifies the input food names into the existing 3,000 food names and 20 exercise names. The detailed method is described in the paper (Aramaki et al., 2008).

Figure 2: The proposed system: "Dialbetics"
A set of health devices (a blood pressure (TOP LEFT), a body weights scales (TOP CENTER), a pad meter (TOP RIGHT), and a blood glucose meter (BOTTOM LEFT)) which share the Bluetooth data transition, a smartphone (BOTTOM RIGHT), and a data transition device to the hospital server (TOP RIGHT).

Figure 3: Self monitoring health data (LEFT).
Colored lines indicate the numerous data of the patient.

Figure 4: A food data (RIGHT).
A cobweb chart indicates a nutrient balance

Table 1: Advice database

Total calorie	Energy content of this food exceeds 640 kilocalories. Do you eat while watching television or reading the newspaper? If people focus on a screen or paper, they tend to eat too much food.
Total Calorie	To maintain adequate calorie intake is important for maintenance of normal weight and good health. Let's get indicated quantity.
Nutrients	
Carbohydrate	Energy content of this food exceeds 640 kilocalories. Do you eat while watching television or reading the newspaper? If people focus on a screen or paper, they tend to eat too much food.
Carbohydrate	*To maintain adequate calorie intake is important for maintenance of normal weight and good health. Let's get indicated quantity.*
lipid	The lipid of this food exceeds the standard level of 18 grams. Excess fat accumulates in our body, and weakens the function of the insulin. You should reduce caloric intake to 400 kilocalories per day.
lipid	The lipid of this food is short. The lipid is one of essential nutrients. Let's eat less than 400 kilocalories per day.

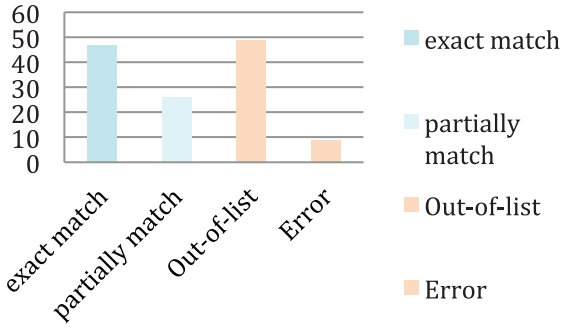

Figure 5: Recognition Accuracy

How much the current NLP could capture the patient data.

The recognition result is shown in Figure 5. Although the accuracy is still not enough (50%), and but the dropout ratio is rare (10%). This result shows the basic feasibility of the proposed result.

Conclusion

This paper introduced the self-health management system, Dialbetics, especially focuses on the text recognition module.

DialBetics may lead to better control of diabetes, improving patient self-management—without significantly increasing health professionals' workloads. More studies are needed for further development.

Reference

Eiji Aramaki, Takeshi Imai, Kengo Miyo, Kazuhiko Ohe: Orthographic Disambiguation Incorporating Transliterated Probability, International Joint Conference on Natural Language Processing (IJCNLP2008), pp.48-55, 2008.