An Initiative Service Method Based on Intention Understanding for Drinking Service Robot

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***Abstract*—To ensure that people can supplement enough water at the right time, an initiative service method based on intention understanding for drinking service robot is proposed. Firstly, individual factors and environmental factors which are associated with personal intentions are collected. Secondly, users' intention and desire degree for intention are obtained by an improved Fuzzy-Context-specific Intention Inference method. Then the relationship between personal intention and human demands is established by an initiative service model. Finally, robots provide drinking water service initiatively according to humans' demands. Drinking service experiments are performed in a laboratory scenario using a humans-robots interaction system. The experimental results show that the drinking time of actual situation lags behind the initiative service time 25 minutes on average, and the initiative service renders drinking service 2 times more than actual situation on average, which demonstrates the feasibility of the proposal. In prospect, the initiative service method could be applied to many occasions in our daily life, e.g., family service, caring for the elderly, and medical rehabilitation.**

I. Introduction

With the improvement of quality of our life, people pay more attention to their health. There is a significant relationship between humans' drinking habits and healthy body. People often neglect to drink water due to tedious daily works, consequently, their body have been in lack of water when they feel thirsty. We lose fluid so rapidly that the brain can not respond in time [1]. Thus a reminder service for drinking water is indispensable to ensure people can supplement enough water in time.

In recent years, service robot is stepping into all aspects of our daily lives to make our life more convenient. Service robots have been used in medical rehabilitation, to help the disabled and elderly, guest service [2], [3], [4], which can implement specific services under users' instructions, however, they are lack of cognitive and emotional interaction with users. To address the problem above, robot behavior adaption and human-robot interaction researches have been done in [5], [6], [7], in which a simple emotional interaction between human and robots is achieved. Although above mentioned studies make robots able to serve for humans, there are few robots are available for drinking service, and can not meet the demands of service for drinking water. Therefore, an initiative service which provide service initiatively according to people's needs is necessary to guarantee people drink water properly in human-robot interaction.

In addition to some information that can be detected directly, including speech, facial expression, etc, human's in-depth thoughts are also indispensable to realize natural and harmonious human-robot interaction. In initiative drinking service, personal intention is necessary, which understands the intricate physiological or psychological changes in human mind according to human cognitive ability and inference ability[8], [9]. Recently, most of service robots execute tasks mechanically according to instructions, without understanding the thoughts and feelings of humans (i.e., human intention understanding).

To solve above problem, an initiative service method based on intention understanding for drinking service robot is proposed, in which individual factors (IF) and environment factors (EF) are both taken into account. Firstly, human intention is obtained through an improved Fuzzy-Context-specific Intention Inference method using individual factors and environment factors. Then the fuzzy relationship between intention understanding and users demands is established by an initiative service model, which includes production rules and fuzzy inference. Finally, robots executes corresponding tasks according to humans' demands. To validate the proposal, drinking service experiments are performed using a multimodal emotional communication based humans-robots interaction (MEC-HRI) system [10], and 5 male and 3 female volunteers that within 18-25 years old participate in the experiments. Comparison experiments between the initiative drinking service and actual situation of drinking in terms of service time and water quantity at each time are done, from which the experimental results demonstrate the feasibility of the initiative drinking service.

The remainder of this paper is organized as follows. Analysis of drinking demands are presented in Section II. The procedure of initiative service for drinking service robot is proposed in Section III. Drinking service experiments and discussion are given in Section IV.

II. Drinking Demand Analysis

Water is an essential part of human's body, since it can help control calories, energize muscles, and maintain normal bowel function. You may be at higher risk for kidney stones, especially in warm climates if you chronically drink too little.

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But when you drink too much water, you may develop water intoxication that may result in hyponatremia, moreover, the process of consuming too much water quickly, would be fatal [11], [12]. The amount of daily drinking water of an adult is 1000 ml - 3000 ml according to a survey [13]. And water quantity at each time is 100 ml - 400 ml approximately. Thus, how often and how much should people drink is an important issue, and it is hoped that the robot can provide drinking service initiatively according to the demands of users to ensure human's health.

The amount of drinking water demand is variable, which is depends on many factors, including individual factors (e.g., physical activity, physical condition, age, and gender), and environment factors (e.g., temperature and humidity).

A. Individual factors

Humans' water demands are vary with individual factors.

1) physical activity: Physical activity increases water requirements that parallel sweat losses for evaporative heat exchange [14]. The body consumes a lot of water after exercise (e.g., running, walking, and talking), which is discrepant sweating rates among different sports. When we exercise, our heart rate speeds up and our systolic blood pressure naturally increases as much as 10 mmHg, or millimeters of mercury [15]. Exercise condition can be obtained by measuring changes in heart rate and blood pressure.

Usually, talking consumes water in the body, and we want to drink water when talking for more than 20 minutes continuously. Thus, it's a signal of water shortage when we speak a lot and the voice is hoarse.

2) Physical condition: Drinking demand of people is closely related to their own physical condition. The amount of water that adults drinks per day is related to the size of their body. Generally speaking, water demands (ml) = weight (kg) * 40 (ml). Drinking demand is related to the nature of user's work. For instance, mental workers, as a result of sitting in the office all day, sweat less, daily drinking water is about 0.0326 times the weight; manual workers, or those who often insist on exercise in their spare time, the daily drinking water is about 0.0434 times the weight[16].

In addition, health issues affect drinking water demands[12]. For instance, people suffering from heart disease, kidney and liver problems are not suitable for general drinking water standards, because too much water will increase the severity of the disease; on the contrary, we need to drink plenty of water to supplement the body fluids to promote the transport of drugs in the body and conducive to the body through the excretory organs of the metabolic waste discharge when a person gets a cold or a fever.

3) Age and gender: Water makes up about 60% of weight in men and 55% of weight in women. Infants are about 70% to 80% water while the elderly are around 45% [17]. A study from Maastricht University in the Netherlands found that women lose more water during exercise than men. And a summary of the median total water intake for each age group for men and women is provided in [18] as shown in Fig. 1. As seen from Fig. 1, water demand increases with age. In United States, the reference daily intake for total water intake is 3.7 litres per day (L/day) for human males older than 18, and 2.7 L/day for human females older than 18 which includes drinking water, water in beverages, and water contained in food[12].

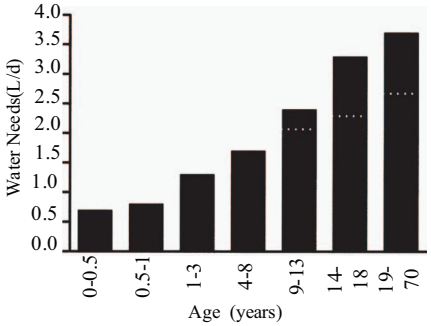

Fig. 1. Relationship between age and drinking need [18]

B. Environmental factors

Environmental factors including temperature and humidity affect people's drinking demands. For example, the amount of water will be increased appropriately when temperature rises or humidity decreases. Water regulates body's temperature. For example, daily water requirements for any given energy expenditure in comfortable temperature (20 °C) would triple in very hot weather (40 °C), and the relationship between temperature and drinking water demands is given in [18] as shown in Fig. 2, which depicts generalized modeling approximations for daily sweating rates as a function of daily metabolic rate (activity level) and air temperature. And it is clear that water requirements are proportional to temperature and activity intensity, which can increase 2-fold to 6-fold from baseline by simple manipulation of either variable. In addition to air temperature, other environmental factors may cause sweat losses, including relative humidity, air motion, solar load.

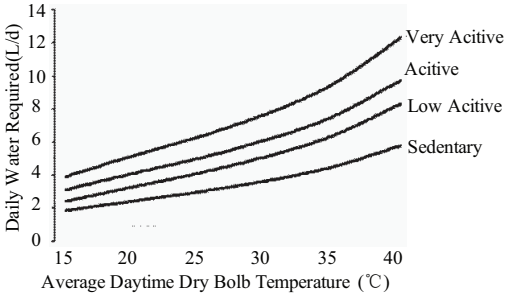

Fig. 2. Relationship between temperature and drinking need [18]

III. Procedure of Initiative Service for Drinking Service Robots

An initiative service method based on intention understanding for drinking service robot is proposed to ensure that people