REFRESH: REcommendations and Feedback for Realising and Stabilising Health

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***Abstract*—This paper describes a recommender system designed to help the user make enhanced life choices and prevent ill health. The system utilises sensors and user interactions, including physiological data, activity monitoring and dietary information. Based on these data the system establishes user needs and provides lifestyle and nutritional advice to the user. To cement behavioural change the system utilises a feedback loop and allows the user to track his progress over time. The system is now in an early prototyping phase and has two main goals: 1) to improve the quality of life for users and 2) to prevent future health problems.**

***Index Terms*—Lifestyle, Health, Prevention, Recommender Systems**

I. Introduction

Much of the ill health in society today is caused by poor lifestyle choices taken over long periods of time. These choices, such as eating poorly, smoking, or failing to do enough exercise, lead directly to conditions such as diabetes, cancer, and obesity. Illnesses of this kind could be prevented through simple and sometimes small lifestyle changes and most people know this. The trouble is that knowing is often not enough because reversing long-term behavioural habits is not straight-forward. There is a large body of psychology research evidencing that changing ingrained behaviour can be achieved if an individual has:

1. Access to personalised (expert) advice that he can relate to his own circumstance (see [1]),
2. a belief in his ability to change (see [2], [3]), and
3. constant feedback that changes in behaviour are having a positive effect (see [4]).

Providing such personalised care is expensive and has historically been beyond the resources of our medical systems. However, technological advances, such as improved and cheaper sensor technology and enhanced artificial intelligence approaches may facilitate a cost-effective solution.

In this paper, we present a prototype system that provides each of the three support aspects required to change user behaviour. The system assists users in taking improved lifestyle choices by recommending personalised dietary changes, recipes and health and lifestyle tips based on an array of sensor data, manual input from users, specified user goals, and (expert) knowledge available to the system. The system also provides feedback on the user's progress allowing the user to understand the consequences of his actions.

II. System Overview

The presented system is being developed as part of a larger multi-partner research project, which aims to provide assistance and improve life quality using technology. As part of the project

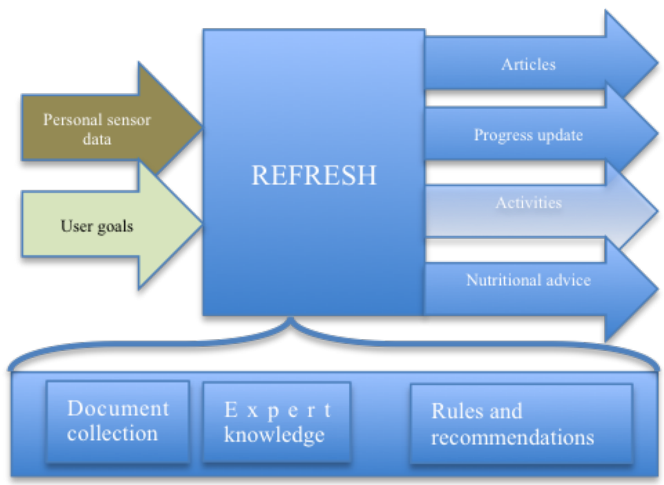

Fig. 1. System Architecture

a smart-apartment is being installed, embedded with a wide range of sensors that can be used to establish and monitor user needs. The system presented here is a specific case study to investigate how such "assisted" living can be used to support and improve health.

Figure 1 provides an overview of the system components.

Inputs: The system takes specified user goals and sensor data as inputs, which inform on user lifestyle and needs. Goals can be provided by the user himself or from a health professional, e.g. "lose 1.5 Kgs over the next two months" or "improve iron levels". A second set of inputs come from sensor data that, in the future, will be enhanced by a further set of sensors provided by the smart-apartment. Currently, our prototype utilises bluetooth scales (see Figure 2(b)), blood-pressure measure, a diet-logging interface designed to easily record user food consumption for nutritional analysis (see Figure 2(a)), and an interface that records basic user properties (age, sex, etc.) and simulates some measures that will, in the future, be captured automatically, e.g. activity levels and sleep patterns.

(Expert) Knowledge: The system contains three forms of expert knowledge. First, it has access to a corpus of appropriate lifestyle / nutritional advice. Apotheken-Umschau[1] is a popular weekly health magazine in Germany. The collection contains several hundred articles, providing information and advice on a

[1] http://www.apotheken-umschau.de/

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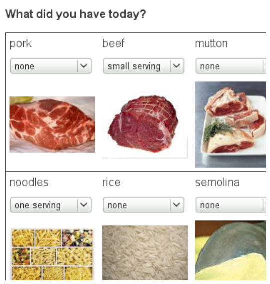
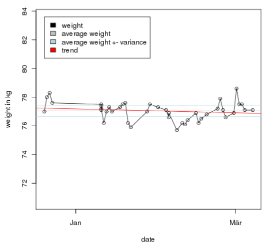


(a) Interface for capturing user dietary information

(b) Bluetooth weight scales



(c) Graphical feedback to the user

Fig. 2.

wide range of health and lifestyle related subjects.

Second, the system also has access to relevance judgements, provided by a qualified medical professional working on the project. These judgements provide information regarding which articles are relevant in particular situations, e.g. when blood pressure is too high, when the user is over-weight, etc.

A third source of expertise comes from the nutritional guidelines set by the World Health Organisation [5]. These guidelines include standard recommendations for vitamin intake and the recommended daily energy intake in terms of carbohydrates, protein, and fats (saturated, monosaturated, and polysaturated). Also included is information about possible effects of vitamin deficiency. Additionally, the system has access to a large database of recipes and associated data including the nutritional values for meals and individual ingredients, the time taken to prepare and cook the meal, and the level of expertise required.

Outputs: The system provides the user with a dedicated, personal advice page. When this page is loaded the user can receive up-to-date information on his health and diet status, as well as be informed regarding his progress towards achieving his own specified goals.

The page consists of three elements: First, there are personalised messages from the system. Examples could be ‘There hasn't been enough protein in your diet today” or ‘Your calorie intake for today was too high”.

A second section provides links to recommended articles from the Apotheken-Umschau. The existing articles are labelled according to their relevance with respect to a set of predefined health conditions (e.g. ‘*elevated heart rate*’). The articles are then ranked relative to the number of appropriate conditions met.

New articles are constantly being added to the system and we do not have relevance judgements for these. We deal with this by using standard information retrieval techniques to derive a mapping between health conditions and natural language terms using the existing set of labelled documents. This allows us to establish the relevance of new documents without the expense of asking experts to judge all new documents.

A third section provides recipe suggestions based on the recipe's nutritional value. For example, if the system detects the user is not getting enough protein it may suggest a protein rich meal e.g. 3-bean chilli. At the moment our recipe recommendation engine is very simple, but in the future, we will build in functionality to allow the user to specify eating preferences (e.g. vegetarian), cooking skills, available time to cook etc.

Finally, the user has the option to track his progress over time through visualisations of sensor data. Figure 2(c) shows an example graph charting one user's weight over a 3 month period.

III. Related Work and Conclusions

In this paper we have presented our system, which places the emphasis on preventing future health problems. The system provides lifestyle advice, specifically tailored to improve the aspects of the user's life most likely to cause ill health in the future. Continuous feedback is also supplied to encourage and support positive lifestyle. Although there are numerous resources for topics such as nutrition and computer-aided support, e.g. Foodurama[2] and NutriNote[3], the evidence from the literature suggests that in relation to health and lifestyle information needs, people have great difficulty in establishing what information to look for and then have problems in judging what information is relevant [6]. Our system exploits technological infrastructure to provide material specifically tailored to the user's needs, which addresses these issues. Additionally, the system allows the user to track his progress.The psychology literature suggests this will close the feedback loop, thereby cementing behaviour change.

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[2] (for details see the web page http://www.syniumsoftware.com/en/foodurama/)
[3] http://www.nutrinote.com/