HORUS.AI - A Knowledge-based Solution Supporting Health Persuasive Self-Monitoring

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Abstract. Automatically monitoring and supporting healthy lifestyle is a recent research trend, fostered by the availability of low-cost monitoring devices, and it can significantly contribute to the prevention of chronic diseases deriving from incorrect diet and lack of physical activity. In this demo we show HORUS.AI, a platform enabling the monitoring of people behaviors by means of knowledge-based technologies for persuading them to follow healthy lifestyles.

1 Introduction

Recent studies like [1] shown that living a healthy life prevents cognitive decline, obesity, disability and death from major chronic diseases (like diabetes, cardiovascular disease, and several forms of cancer). In the domain of health and well-being, the use of Information and Communication Technology (ICT)-based motivational systems that produce user-tailored messages that can be effective tools to persuade and motivate people to change their behavior toward a healthier lifestyle (adopting and maintaining correct diet and active living).

However, engaging people in developing and maintaining healthier patterns of living is a challenging task. To this end, generating effective personalized recommendations implies, for example, the justification of given suggestions and the adaptation of messages in response to the modification of the environment and of the user status.

In this demo, we present a motivational platform for supporting the monitoring of users' behaviors and for persuading them to follow healthy lifestyles [3,4,5,6].

Semantic technologies are used for modeling all relevant information and for fostering reasoning activities by combining user-generated data and domain knowledge. Moreover, the integrated HeLiS ontology [7,8] supports the definition of the dynamic interfaces used by domain experts for designing the set of rules exploited for the monitoring activity. Contextually, our system aims at inducing the user to follow specific behaviors and to maintain them over a certain timespan.

2 System Implementation

The system relies on the four (4) layers shown in Figure 1.

Input Layer The *Input Layer* is responsible for detecting events triggering the platform activities and accounts for the ability of a persuasive system of sensing the context of interaction. These events are of two types: (i) data input, where data are sent from the

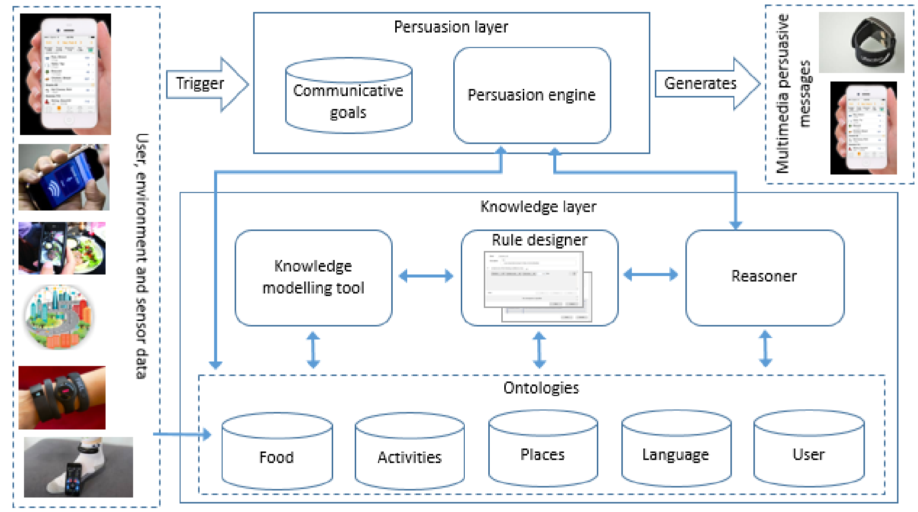

Fig. 1. The schema of the proposed platform architecture.

Input Layer to the *Knowledge Layer*, and (ii) context communication, where contextual information is sent from the *Input Layer* to the *Persuasion Layer* that may exploit this information for persuasive purposes.

Here the distinction between data input and context communications relies on the use of parameters by the system. Input data represent facts of the world related to the user's behavior that trigger knowledge layer rules in the specific domain (e.g., the assumption of meals encouraged or discouraged by the Mediterranean diet recommendations). Context communication is related to the environment in which the user is acting (e.g. timing or localization), and provide information to the *Persuasion layer* allowing the choice of the most appropriate message generation strategy.

Knowledge Layer To support natural argumentation and (emotional) persuasion and to allow reasoning on the possible arguments to be put forward, we defined methods for representing knowledge, for reasoning on it, and for generating natural language and multi-modal messages (both in monological and dialogical situations). Based on this consideration, we developed a *Knowledge Layer* encompassing two kinds of information:

- Augmented Domain Knowledge: the structured representation of the domain of interest including those relations that are relevant for persuasion purposes, such as the similar-taste relation or the categorization of food properties into negative and positive ones. Moreover, we included all the concepts supporting the description of the undesired situations detected by the reasoner and the relationships between them. These concepts furnish the basis for the *arguments* included in the feedback provided to users.
- Monitoring Knowledge: the structured representation of the rules driving the behavior change process (i.e. the rules that a user should follow). Here, we defined

the aspects of users' behaviors that have to be monitored by the platform in order to produce proper feedbacks (e.g. the categories of foods that should be consumed and their optimal quantity).

Persuasion Layer In the *Persuasion Layer* we designed an effective Natural Language Generation (NLG) persuasive system. We expanded on the idea presented in [9] of a classification of basic persuasive strategies (what to say, how to say), supporting strategies (i.e., strategies that are meant to give support to a specific claim) and a meta-reasoning model that works on these strategies (selection and ordering of basic strategies).

The *Persuasion Layer* exploits the output of the *Knowledge Layer* (i.e. reasoning operations) for choosing the persuasive intentions to include the generated messages, and focuses on the tasks of selecting the arguments to include in the message, to order them, and to choose the right wording for each argument.

The role of the *Persuasion Layer* is not limited to the generation of single messages. Indeed, the application of a persuasion strategy generally requires more than one interaction with the user. Thus, the *Persuasion Layer* is also in charge of managing the relationships between single messages and understanding information provided by users in order to built a reasonable conversation with the user.

Output Layer Finally, the *Output Layer* is in charge of closing the loop by providing the feedback to users. It is represented by one of many devices able to receive the data produced by the *Persuasion Layer* and to convey the physical feedback to users. This layer manages two dimensions of interaction with the user: the *Type of feedback* and the *Presentation* The former determines the optimal way for communicating with users. This choice is strongly associated with the kind of device used for providing the feedback. The latter manages how content generated by the *Persuasion Layer* is presented to users is relevant for completing the process of supporting the behavior change. Finally, the output provided by the platform could also be a further request of inputs. Thus, a connection between the two layers has been implemented.

3 HORUS.AI in Action: What we Will Show During The Demo

The physical demo will be split in two parts: (i) the mobile application freely available on the markets that will be installed, if requested, by the attendants [1], and the back-end used for creating and configuring users' profiles and for defining the rules exploited for monitoring purposes. Then, we will show in particular the following modules.

Profile Creator. This set of facilities is thought for creating monitoring profiles that are then associated with specific users or with groups of them. People enabled to using these facilities are domain experts (i.e. physicians) because information managed in the back-end could be related to the clinical profile of users. Thus, only authorized people can access. We will show how domain experts can set-up groups and users, and how they can create and assign profiles to them.

Rule Generator. Each profile generated into the platform has to contain one or more *monitoring rules* in order to enable the monitoring of the users associated with

[1] https://play.google.com/store/apps/details?id=eu.fbk.trec.lifestyle
https://itunes.apple.com/it/app/lifestyle-work/id1351897838?mt=8

each profile. Rules are provided by the domain experts through an interface built on top of the underlying HeLiS ontology that guides the domain experts to the definition of each rule. We will show the structure of the interface, how it is populated, how it responds to the changes of the ontology, how a rule can be defined, and in which format it is saved within the underlying ontology.

Live Reasoning. Once a user is associated with a profile and such a profile contains the related set of rules, the system is able to monitor user's behavior. The monitoring task is performed through a SPARQL-based reasoner that combines profile information, rules, and data provided by the users for detecting possible unhealthy behaviors. We will show how the reasoner works, the steps it performs on the data and we will show its efficiency within a live environment.

Personalized Feedback. The process ends with the generation of the feedback sent back to the user. We will show how to install and configure the mobile application linked to the HORUS.AI platform. The attendants will be associated with a profile and we will explain them how to provide data. Then, we will show how the HORUS.AI reasoner generates feedback by taking into account the selected profile and the provided data.

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