An Interface for managing users' preferences in AmI

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***Abstract*—One important concept of Ambient Intelligence (AmI) is meeting the user needs unobtrusively. To meet such needs, it is crucial to provide way(s) that will allow users to indicate their preferences to the system and allow users update them easily. As this will be used by the system to reason about their preferences and better align services with users behaviour. The paper aim to identify an effective way to manage, represent and reason with users preferences. A simple interface for managing users' preferences was provided to help manage and resolve some of the complexities in users' preferences. The interface also relied on textual menus for simplicity. Videos demonstration have been provided to show how the interface effectively works with a reasoning system in a smart house, providing different results when there is a change in users' preference(s).**

***Index Terms*—Interface, Users Preference, Ambient Intelligence, Smart House, Reasoning System**

I. Introduction

As mobile devices grow in functionality and popularity, the demand for advanced mobile applications in human daily life increases [1]. Graanin et al [2] emphasises how mobile technologies have the potential of connecting users with their environment, and how smart environments enhanced with technology to support better living, may improve individuals lives. However, it is still a major issue to design and develop a flexible interface application that matches many users' needs and provide them the usability and quality experience they require [3]. In this paper, we present a simple interface solution, that gives users the ability to modify their preference ranking(s) from their mobile phone at their convenience. This in turn allows the system to provide different results when there are change(s) in their preference ranking. The paper is further organised as follows. Section II emphasises the problems of having a simplified and easy to use interface in the AmI and the need to have one that can be used even by older adults, and yet handles and resolves complex preference problems. Section III presents the interface, some description of how the interface functions and also a brief scenario. Section IV demonstrates how the interface works effectively with a reasoning system to handle changes in preferences. Lastly, section V concludes the paper and provides potential ways of improving the interface for better management of users' preferences.

II. Some challenges on interfaces in AmI

Preferences handling has been known to be a core issue in designing an automated system that aims to supports the decision making of the users [4]. It can be more challenging when users find it difficult to handle the technology(interface) that is supposed to manage their preferences. This is already an issue for the elderly, as it is difficult for them to be involved in technological activities [5].

One common proposed requirement (which tends to be a challenge) when designing a mobile interfaces, is for the users to be able to interact with the interface with easy, and less buttons/clicks(interactions) [6], [7]. Although, [8] developed an interface known as "Motile", that rely on just four buttons for user inputs. Also an interesting idea was presented by [9] known as assist-robot interface, that works in Portable-Mode (when the user is not at home) and Robot-Mode (when the user is at home), and so on.

However, these interfaces might not be ideal for all users in AmI, especially for older adults whose technical experience tends to decline and it limits their ability to use and interact with technology user interfaces [10], [11]. In addition, these interface applications cannot handle the management of users' preferences, especially when the user wants to have control over their own preferences within their environment.

This paper provides a simplified interface, incorporating the idea of a preference sort, *pref*, introduced by [12]. This allows users to select and rank their preference(s) at a convenient time from the developed interface. Depending on the how the users preferences were ranked using the simplified interface, the system output will change. The interface was developed to give the user the ability to prioritize their preferences, and give them the ability to modify it at any time, using their mobile phone and the changes will take effect immediately.

III. Managing Users' Preferences

Preferences can be imposed to a certain extent, such as doctor's recommendation, adjustment in lifestyle, the need to do a certain activity etc. [13]. Preferences have a number of complexities as they may change over time or clash with each other. For example, sometimes there may be reasons to

keep the lights 'on' and other reasons to keep them 'off' at a particular time. Therefore, balancing of these users' preferences is a crucial factor in AmI [14], so that the system should be effective enough to support users' needs. This paper will give a brief scenario, followed by a demonstration of the scenario, to illustrate how the developed interface works with a reasoning system to manage the preferences set by a user.

A. Setting up new user's Preferences, (Bobby).

Scenario: *Bobby, an aged individual who lives alone, prefers the light to be 'off' when he is asleep at night to provide more comfort. However, he might sometimes prefer the light to be 'on', so it is safer for him to move around when he wakes up in the middle of the night.*

The interface has been developed in a simple manner where the existing users can easily retrieve their preference profile, or set up a new profile on the same page. The home page has two options, the drop-down list to display existing users or a text-box to enter the name of new user. Creating a new user will generate the same list of pre-defined preferences currently in the system. The users has to adhere to them, as we are currently working with strict preferences (second part of figure 1 depicts the strict preferences we are currently working with). Though the interface has been designed in a way to edit, delete or add more preferences directly from the database.

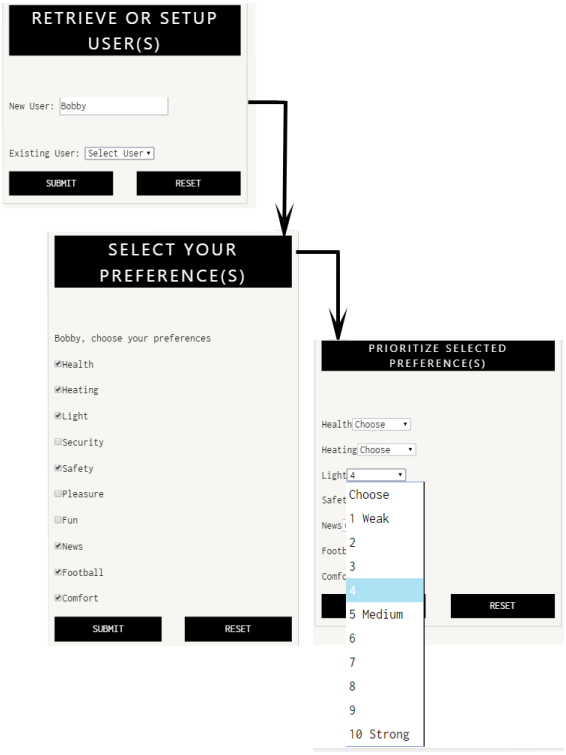

Fig. 1. Simple setting up of new users' Preference (Bobby).

On the page containing the list of preferences, the user just needs to check the boxes of the preference(s) that applies to them or which preference they want to rank. The user does not need to check all the boxes from the list of the available preferences, as the idea is to give users the ability to choose and prioritize the preference(s) they want. The selected preference(s) will be transfer to the third page where the user can now prioritize and store them in the database, ready to be used immediately. Each preference can be ranked from 1-10 by the user, with 10 being the highest priority. Figure 1 illustrates the setting up of a new user (Bobby).

The aim is to provide a simple and easy to use interface, that will not create any form of complexity for the user, and still be effective enough to carry out the complexities in preference management with the reasoning system. Research aimed at a focus group and contextual inquiries of potential smart home inhabitants [6], indicate that, users want a control that is as simple as possible, and the interaction for usage should consist of around 2-3 buttons. The same research also found out that users want the interaction method to be consistent, easy to use and familiar, as they want to feel in control of their home environment [6].

B. Modifying Bobby's Preferences

As initially stated, preferences may change over time and can be modified based on experience or other reasons. The interface also has a simple mechanism to modify the existing users' preference(s) which will change the output/decision the reasoning system will provide for the user. Figure 2 illustrates two steps of modifying the ranking of existing preferences (Booby in this case) and saving it.

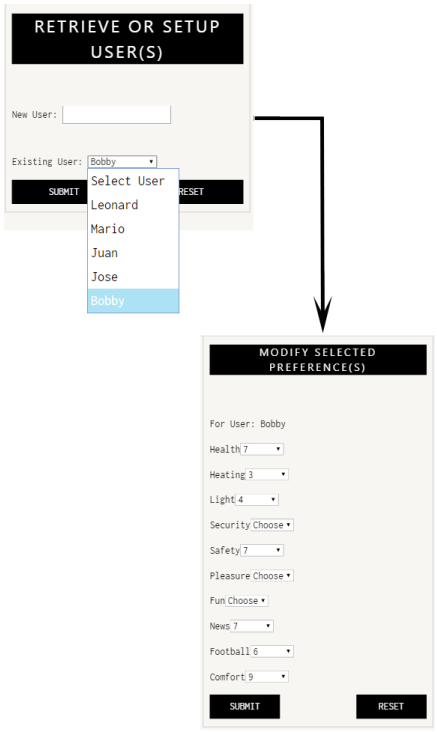

Fig. 2. Retrieving and modifying existing preferences (Bobby).

Despite the user setting and ranking up their preferences (which is a one-time procedure for new user), we needed to

make sure the interface is easy to learn and consistent for every user regardless of the individual. The first page of figure 2 is where the user selects their name, and then it loads their profile on the next page, for modification and updating. Also, if the user has not specified any ranking for a preference at the initial stage of creating their profile, they can also do so when modifying their existing preference(s), if they choose.

IV. Using Preference Interface To Affect System Behaviour.

To Illustrate the functionality and effectiveness of the developed interface within a smart home environment so as to manage users' preferences, other systems are required. A reasoning system (MReasoner, [15]) to run the specification file, a router, known as Vera, which provides the framework to control sensing devices (light sensor, movement sensor, pressure pad etc.) working with Z-wave sensors and the interface to manage the preferences. The reasoning system, will run the specification file (partially shown in figure 3), and with the occurrence of some event (e.g. *BedRoomMovement*) the required action(s) will be triggered in the smart house. Basically, the information that is entered from the interface is stored in the preference database(DB), and updated immediately anytime the user modifies their preference(s). MReasoner on the other hand, when running, continue to read the preference DB and when there is/are any update(s) in the DB (made by the user), MReasoner immediately use the current update(s) and apply the necessary changes to the system.

A. System Specification for MReasoner

Below is the complete system specification that will be fed to the reasoning system, which the smart home will react to. The specification refers to the scenario in section III-A.

```
states(CorridorMovement, CorridorLight,
ToiletLight, ToiletMovement, BedRoomLight,
BedRoomMovement, BigPadIdle, prefLight,
prefComfort, getup, siesta, nightsleep);

is(CorridorMovement);
is(#CorridorMovement);
is(ToiletMovement);
is(#ToiletMovement);
is(BedRoomMovement);
is(#BedRoomMovement);
is(BigPadIdle);
is(#BigPadIdle);
is(prefLight);
is(prefComfort);

holdsAt(#CorridorMovement, 0);
holdsAt(#CorridorLight, 0);
holdsAt(#ToiletLight, 0);
holdsAt(#ToiletMovement, 0);
holdsAt(#BedRoomLight, 0);
holdsAt(#BedRoomMovement, 0);
holdsAt(#BigPadIdle, 0);
holdsAt(prefLight, 0);
holdsAt(prefComfort, 0);
holdsAt(#siesta, 0);
holdsAt(#nightsleep, 0);
holdsAt(#getup, 0);

ssr((<->[13:00:00-16:00:00]#BedRoomMovement
        ^ #BigPadIdle) -> siesta);
ssr((<->[23:00:00-06:00:00]#BedRoomMovement
        ^ #BigPadIdle) -> nightsleep);
ssr((siesta ^ BedRoomMovement ^ BigPadIdle)
                       -> getup);
ssr((nightsleep ^ BedRoomMovement
           ^ BigPadIdle) -> getup);
ssr((getup) -> BedRoomLight);
ssr((CorridorMovement) -> CorridorLight);
ssr((#CorridorMovement)-> #CorridorLight);
ssr((ToiletMovement) -> ToiletLight);
ssr((#ToiletMovement) -> #ToiletLight);
ssr(([-][30s.]#BigPadIdle ^
        #BedRoomMovement ^
        prefLight) -> BedRoomLight);
ssr(([-][30s.]#BigPadIdle ^
        #BedRoomMovement ^
         prefComfort) -> #BedRoomLight);
```

The first part of the system specification refers to all the states in the house that are needed for the scenario (III-A). The second part of the specification (e.g. *is(BedRoomMovement);* refers to Independent States, which do not casually depend on other states and can be either true or false. The third part are the Initial Status values for each of the states. For instance, *holdsAt(#CorridorLight, 0);*, means the corridor light should be 'off' at the start of the scenario. The fourth part of the specification are the rules that triggers the actions. The selected section of the rule in figure 3 where we have *prefLight* and *preComfort* respectively, means the bedroom light should be 'on' if the user prefers *Light* or the bedroom light should be 'off' if the user prefers *Comfort*. Figure 4 depicts and overall preference management architecture of how information coming from the external world (e.g. sensors, internet) and/or from a user (through preference interface), can change the conclusion using preferences (including the ability to cope with competing and conflicting preferences. The next section of this paper contains video links, illustrating the aforementioned scenario and how the interface interact differently with change in preference.

B. Video and Demo

This research provides videos demo, illustrating how the reasoning system and interface works, and also depicting how the smart home reacts differently when there is a change in preference ranking. The link (https://mdx.figshare.com/s/44bdb4b7947f6ca8921d) contains two videos indicating how the house react when there is a change in preferences, such as

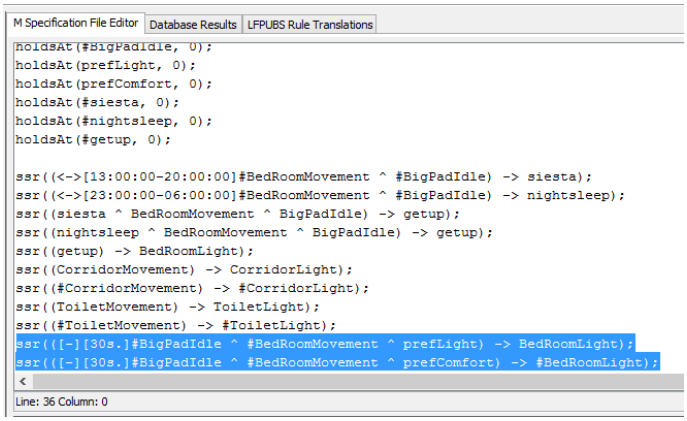

Fig. 3. Reasoning system (MReasoner) screen-shot with system specification details, to illustrate change in response based on preference ranking.

user prioritizing Light over Comfort or vice versa. When Bobby prioritizes light over comfort, it means he wants to keep the lights 'on' when he is asleep and when he prioritizes comfort over light, he wants the light 'off' when he is asleep as its more comfortable.

V. Conclusion and Further Work

Ambient Assisted Living (AAL) is one of the crucial research and development fields, where usability, learning and accessibility play an important role, and interfaces are important for applied engineering [5]. Therefore, delivering a smart system for AmI is not just about providing an effective and efficient system. Simplicity and ease of use should be a necessity that has to be considered when developing systems that will meet the needs of the users, thereby reducing complexities. ISO/IEC [16] further described usability as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. This paper provided an interface that enables users to easily manage the preferences in a smart home, as users should be empowered to personalize systems according to their preferences and this should be reasonably easy to do [17]. The interface can further be improved in the following ways:

- Collaborate with end users in validation
- Controls will be modified for better navigation
- Mobile app version with better looking interface

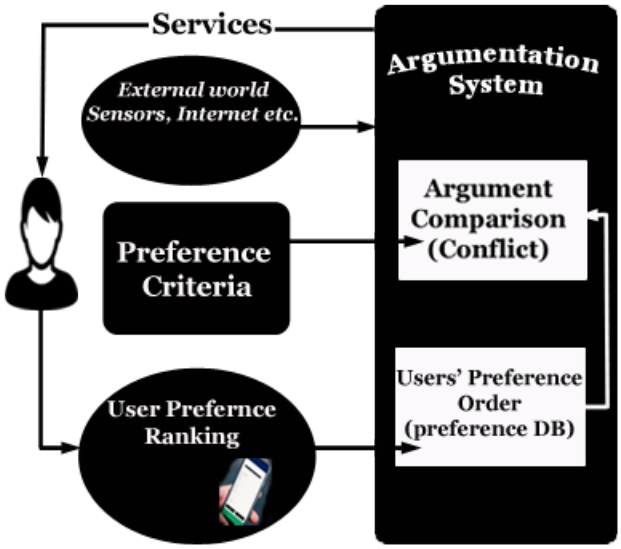

Fig. 4. Overall architecture of preference management system

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