

# Towards a Back-End Framework for Supporting Affective Avatar-Based Interaction Systems

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**Abstract.** Avatar-based systems provide an intuitive way of interacting with users in the context of Ambient Assisted Living (AAL). These systems are typically supported by a diverse set of services for, e.g., social daily activities, leisure, education and safety. This paper studies the importance of specific services for two organizations, namely MRPS in Geneva, Switzerland and ORBIS in Sittard, Netherlands. Based on this study, we present the design of a backend framework that supports Avatar interaction by means of a comprehensive set of services for safe and independent living.

## 1 Introduction

Advances in animation technology, natural language processing, motion tracking and sound sensing have enabled human-like graphical representations that allow people to interact with intelligent systems in a non-intimating human-like manner. To date, such *Avatars* have found many interesting applications in various settings including Internet forums, remote support, games, and education.

More recently, research has been directed towards studying the effect of Avatars in the context of AAL in order to motivate elderly citizens (65+) to remain active during their daily life at home [1–3]. The idea is to prolong independent living and improve quality of life. Within these projects, Avatars consider facial expressions, voice intonation, gestures and other contextual information of the user’s environment in order to provide empathetic responses with animations and voice intonations. This is typically realised by the use of services that stimulate and motivate the user to act independently. At the same time, these services increase a user’s social interactivity with family and caregivers, while identifying potential dangerous situations for which users are warned about.

This paper presents the architectural design of an innovative back-end framework that supports Avatar interaction along the aforementioned lines. This framework employs a sophisticated model that incorporates different sensor feeds, as well as historic behaviour analysis, to better assist the elderly.

The rest of the paper is organized as follows: Section 2 discusses the results a user study that identifies vital services for Avatar-based systems. Section 3 presents the design of the proposed framework. We conclude in Section 4.

## 2 User Need Analysis

In order to identify the most important services for elderly users, we perform a systematic analysis to investigate their requirements and needs, as well as those of their caregivers. The study focuses on services that enable users to remain active and independent but also improve their overall well being and safety.

Two end user organizations were involved in the study: Maison de retraite du Petit-Saconnex (MRPS) in Geneva, Switzerland and Orbis Medisch Centrum (ORBIS) in Sittard, Netherlands. A total of 37 elderly users, aged from 60 to 90 years old, as well as their caregivers, participated in the study. We utilised structured questionnaires, focus groups and semi-structured interviews to ensure that enough context data was provided. During the study, the elderly were able to ask for clarifications, elaborate on ideas, and explain their own perspectives. The study involved two separate sessions, one for elderly and one for caregivers, where in both cases the respondents first participated in a group session which informed them about the purpose of the study.

The questionnaire presented to both the elderly and caregivers comprised 23 questions and aimed at investigating their preferences regarding the services offered by the Miraculous-Life solution. Users were asked to rate the importance of a service in an Avatar-based system using a 5-point Likert scale (1 = Very useful, 2 = Useful, 3 = Indifferent, 4 = Not very useful, 5 = Less useful).

The conclusive results of this study reveal that both elderly users and caregivers consider a particular set of services to be vital for an Avatar-based system. More specifically, both the elderly and caregivers consider services that stimulate daily activities (e.g., care activities, relaxing activities, motivation for physical activities and shopping assistance) very important as they prolong active and independent living in a home environment. As a result, they delay admission to hospitals and nursing homes and reduce stress, as well as the demand for care resources, which includes the associated burden to formal and informal caregivers. Additionally, users believe that appropriate notifications for such services and suggestions for activities that they have not yet participated in (e.g., new upcoming events) are equally important.

Monitoring and safety services (e.g., fall detection, call for help, obstacle avoidance, medication reminders and dangerous situations adviser) are also very important to users since they provide them with assurance that they are being thoroughly attended. However, numerous privacy concerns were raised for these services, which should be taken into account when developing the corresponding security/privacy infrastructures.

Finally, some services such as services for hygienic and household advice, teleconferencing, education, and physical activity motivation were classified as "good to have" for improving overall well being, but not vital.

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Example of a question that was utilized in the questionnaire: "How useful a system that could be able to teach you how to prepare different meal recipes?"

The detailed results and statistical analysis of the questionnaire are not included in this paper because of page limitations

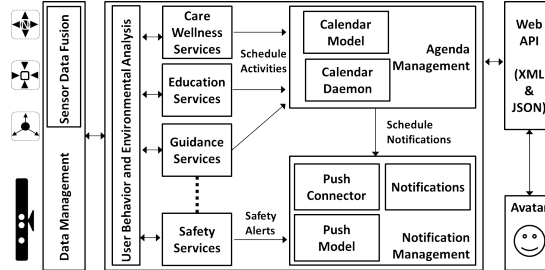


Fig. 1. The proposed framework architecture

### 3 Framework Architecture

We took into account the above results to design an innovative framework that can support the aforementioned services. The high-level architecture of this framework is illustrated in Figure 1. It currently supports a number of services, which can be roughly classified as follows:

- **Care & Wellness:** their objective is to provide support and care to the elderly. Some representative examples of services in this category include: i) *daily activities*; ii) *medication management*; and iii) *household adviser*.
- **Guidance:** their objective is to provide stimulation and support to the elderly for maintaining a healthy lifestyle. For this category, representative examples include: i) *motivation for physical exercises*; and ii) *assistance in locating objects* at home.
- **Safety:** their objective is to detect possibly dangerous situations by analysing high-level environment contextual information and to provide emergency workflows to aid the elderly. Representative examples of such services are: i) *fall detection* using the kinect camera; ii) *obstacle avoidance*; and iii) *reminders for switching off potentially dangerous devices* (e.g., cooking stove).
- **Education & Leisure Services:** their objective is to educate the elder and also provide recreational activities. Some representative examples of services in this category include: i) *meal preparation*; and ii) *events and group activities*.

After performing an in-depth analysis of the operational requirements of all implemented services, we found many similarities in the user interaction workflows used. For example, the majority of services (e.g., daily activities, events, group activities, medication reminders) require the addition of agenda entries in the user’s calendar and the generation of corresponding notifications to remind the user. Additionally, in some cases there is a need for communication between the caregivers and the elderly.

In order to ensure a flexible and open design, as well as to create a robust unified model for user interaction, we analysed the overlapping functionality and

incorporated additional components in our design for interoperability purposes. In particular, we designed an *agenda management* component based on the popular RFC 5545 and RFC 7529 standards, which are utilized by the majority of software vendors. This component enables all required services to interact with a user's calendar in a unified manner, i.e. using a straightforward API that supports typical functionality (e.g., create a one time event or a weekly activity). At the same time, it supports any advanced functionality for recurring events as specified in the RFC 7529 standard. Additionally, the proposed framework utilizes a unified *notification* engine that allows services, including the unified Agenda Management, to create reminders and notification for users.

In order to support intelligent services that account for the current state of the user (e.g., emotional state, recent behavior, environment), we also created a unified user behavior and environmental analysis component that monitors the user's state and its environment. Monitoring is achieved through sensor components (e.g., kinect, pressure sensors) and service interaction (e.g., activities performed) recorded with logs at the database level. This component enables services to query for information regarding the user's current state (e.g., emotional state tracked by gestures, face recognition, periods of user inactivity) and dynamically adapt their output (e.g., send notifications augmented with emotional context to the Avatar system, which can then disseminate to the user in an empathic manner).

Finally, all framework functionality is exposed through a comprehensive web-based API that enables it to be easily integrated with any Avatar-based system.

## 4 Conclusions and Future Work

We presented a user study performed at two end user organizations to reveal the importance of specific services to AAL projects. This enabled the design of a new framework of services, which aim at increasing the quality of interaction between users and services of any Avatar-based system. This framework can therefore yield the better adoption of AAL systems at large. In future work, we plan to implement and evaluate the effectiveness of the proposed framework.

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