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Silver assistants for aging-in-place

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Silver Assistants for Aging-In-Place

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***Abstract*—In this demo, we present an assembly of silver assistants for supporting Aging-In-Place (AIP). The virtual agents are designed to serve around the clock to complement human care within the intelligent home environment. Residing in different platforms with ubiquitous access, the agents collaboratively provide holistic care to the elderly users. The demonstration is shown in a 3-D virtual home replicating a typical 5-room apartment in Singapore. Sensory inputs are stored in a knowledge base named Situation Awareness Model (SAM). Therefore, the capabilities of the agents can always be extended by expanding the knowledge defined in SAM. Using the simulation system, we can rapidly conduct various types of experiments to test and evaluate whether the silver assistants have effectively and reliably fulfilled their duties when serving the elderly.**

I. Introduction

The world's population is aging and nowadays more elderly choose to live in their own homes as long as possible. To support their independence and to ensure their safety, various types of technologies have been developed to meet the rapidly increasing needs for Aging-In-Place (**AIP**). Such technologies include smart home applications, reminder systems, medication adherence assistance, anomaly detection, etc. These technologies are extensively studied in the specific domains. However, they may not be easily extended and be readily integrated with the others. In this paper, we present an assembly of silver assistants who provide holistic elderly care with ubiquitous access. These virtual agents have their own specialties while sharing a common knowledge base named Situation Awareness Model (**SAM**). As such, the capabilities of the agents can always be extended by expanding the knowledge defined in SAM. For demonstration purpose, SAM receives simulated sensory inputs from a 3-D virtual environment, which replicates a typical 5-room apartment in Singapore. In the virtual home, we can either control manually or automatically with a script, the behavior of the 3-D avatar (elderly occupant) performing various Activities of Daily Living (ADLs). Meanwhile, the changes in the environment are reflected in SAM in real-time. Based on the sensed context in SAM, the agents decide whether the elderly occupant requires any specific assistance or general companionship. The agents can provide a broad range of assistance, reminders, recommendations, and companionship for physical, cognitive, emotional, social, and sustainability supports [1]. To promote a healthier lifestyle, the agents would try to convince the elderly [2] if they do not show interests in certain recommendations. Moreover, to enable the agents to collaborate with maximum efficiency and minimum misunderstanding, we define a coordination proxy [3] for them to communicate with the others. The overall system framework is illustrated in Fig. 1 and the details are elaborated in the following section.

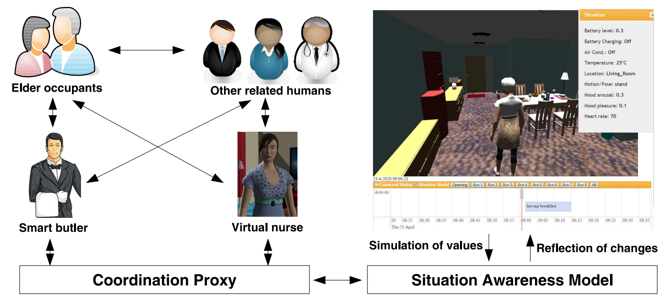

Fig. 1. The overall system framework of silver assistants for aging-in-place.

II. Silver Assistants for Aging-In-Place

The purpose of the silver assistants is to provide holistic care. They serve the elderly in various ADLs and interact with the concerned parties for general updates and reports of anomaly. For example, if the system detects a fall [4] and does not receive a positive response from the elderly within certain time, the agents will alert the emergency contact immediately. Currently, we have developed two silver assistants for demonstration, namely smart butler and virtual nurse.

The smart butler (see Fig. 2b) resides in mobile devices such as a smartphone (which has a high penetration rate of 83% among senior Singaporeans in 2012), which are constantly carried around by the owners. The butler, as its name suggests, provides all-round tender care through frequent natural interactions (speech and taps). Its context panel displays the peripheral information. It provides various types of applications via the respective buttons in the function panel being pressed. Most importantly, the interaction panel delivers all types of messages (reminders, recommendations, small talks, etc.) and learns the user response by identifying the respective response button being pressed. More details can be found in [1], [5].

The virtual nurse (see Fig. 2c) resides in the home computer [1]. Again, as its name suggests, the nurse specializes in healthcare: promoting healthy lifestyles and providing health related recommendations to the elderly. It naturally interacts with the elderly through speech and mouse clicks and its most unique features include the use of a computational model for adaptive persuasion. More details can be found in [1], [2].

The agents can only make sensible decisions if they are fully aware of the situation. Therefore, we use SAM to store all the real-time collected sensory inputs and to make inferences. There are mainly four types of situational attributes defined in SAM: (1) Inputs from home-installed sensors[1] (e.g., ON/OFF

[1]Another team in our research centre is currently working on how to reflect the changes sensed in the real-world inside the virtual environment.

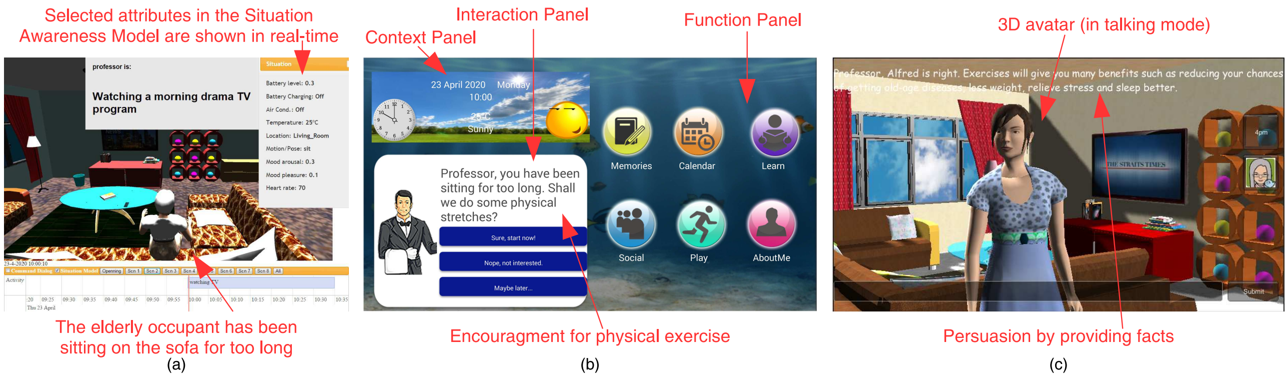

Fig. 2. An exemplar scenario wherein the two agents collaboratively encourage the elderly occupant to do some physical stretches after the Situation Awareness Model infers that she has been sitting on the sofa for too long.

switches, RFID trackers, acoustical sensors, etc.); (2) Inputs from mobile sensors (e.g., motion [6], mood [5], heart rate from smart-watch, etc.); (3) Online activities (e.g., activities on social network services, news crawled online, etc.); and (4) Inferred context (e.g., few phone calls lately, sitting for too long, etc.). SAM is designed in such a way that all the sensory inputs can be collected in the real-world environment.

For demonstration and experimental purposes, a 3-D virtual world (see Fig. 2a) is implemented to simulate a real-world indoor living environment, wherein the situation is captured and reflected in real-time by the situational attributes in SAM. In this demo, we develop a number of scenarios to simulate various activities of the elderly occupant in a day.

III. Demonstration Scenarios

Our demonstration scenarios serve to illustrate the five main types of care provided by the silver assistants [1], which are presented as follows: (1) Physical care, such as fall detection and encouragement for exercise; (2) Cognitive care, such as medication adherence and reminder for unattended stove; (3) Emotional care, such as greetings, conversations, and music selection; (4) Social care, such as event recommendation and suggestion for social contact; and (5) Sustainability care, such as suggestions for energy-saving and phone-charging. Due to the page restriction, we only present one selected scenario[2].

In the illustrated scenario (see Fig. 2), SAM sensed that the elderly occupant had been sitting on the sofa for too long and subsequently updated the respective inferred context. Both the smart butler and virtual nurse noticed the updated context and wanted to suggest some physical stretches. Before interacting with the elderly, the agents communicated through the coordination proxy and agreed that the smart butler would initiate the conversation. However, when the elderly occupant was reluctant to follow the advice, the butler asked the nurse for support. The nurse agreed with the butler and persuaded the occupant in a personalized manner according to her motivation and responses [2]. At last, the elderly occupant recognized the benefits and agreed to the suggestion of physical exercise. In summary, this demonstration scenario shows: (1) Interactions among the two agents and the human user; (2) Collaboration between the agents; and (3) Adaptive persuasion.

[2]The presentation slides prepared for the demonstrations are available online: https://www.dropbox.com/s/51zqbzksoq9mf3j/SA4AIP.pdf?dl=0

IV. Conclusion and Future Work

In this paper, we present a framework for supporting aging-in-place, consisting of an assembly of silver assistants and a virtual environment simulating a typical apartment in Singapore. Through various demonstration scenarios covering the physical, cognitive, emotional, social, and sustainability aspects, we show how the overall system achieves the objectives as designed. For future work, we will conduct experiments to evaluate the effectiveness of the agents by simulating different behaviors of the elderly occupants. In addition, we aim to enhance the representation of knowledge in SAM so that users may define new rules and the rules can further be learned and tuned adaptively through interactions.

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