Helping Early Stages Alzheimer´s Disease Individuals and Their Caretakers with a Voice Recognition Mobile Augmented Reality System

Keynes Masayoshi Kanno
Edgard A. Lamounier Jr.
Alexandre Cardoso
Federal University of Uberlândia
Uberlândia, MG, 38400902, Brazil
keyneskanno@gmail.com
lamounier@ufu.br
alexandre@ufu.br

Ederaldo José Lopes
Gerson Flávio Mendes de Lima
Federal University of Uberlândia
Uberlândia, MG, 38400902, Brazil
ederaldo@ufu.br
gersonlima@ieee.org

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Abstract
An important public health problem is Alzheimer´s Disease (AD). Studies show that AD is the most common cause of dementia in older adults. In addition, a large percentage of patients and their caretakers still face enormous challenges on treatment and everyday tasks. Forgetfulness and location awareness are recurrent symptoms. On the other hand, smartphones is part of their daily lives. Therefore, this paper presents a mobile application to help individuals with early stages Alzheimer´s Disease to identify objects and people. In addition, it can track the location of an AD individual, since they commonly get themselves lost. We propose an accessible interface, based on Augmented Reality techniques, that uses speech commands and virtual buttons for different features: time reminding to take medicines, identification of which remedy to be taken, people recognition from photos and others. Tests revealed a promising interface using voice recognition and feasibility in locating individuals in outdoor environments.

Author Keywords
Alzheimer´s Disease; Mobile Technology; Augmented Reality Interface; Assistive Technology.

Figure 1. The app reminds and identifies for the individual with AD or the caretaker, the correct medicine box indicated by a red arrow sign and with a spoken alert.

ACM Classification Keywords
K.4.2 Social Issues: Assistive technologies for persons with disabilities.

Introduction

Alzheimer's disease (AD) is the leading cause of cognitive decline in elderly, accounting for more than half of the cases of dementia. At the present moment, AD has no cure, however, there are pharmacological and non-pharmacological treatments that allow individuals to live better, along with contributing toward slowing down the effects of the illness [17].

Given the condition that this illness puts on the sufferer, it is important to highlight the overload placed also upon caregivers in order to assist them in the basic activities around their daily routines and instrumental activities concerning basic functions [11].

Assistive Technology (AT) contributes to and assists in the better execution of daily life activities. Augmented Reality (AR) has contributed to assistive technology over recent years. AR supplements the real world by inserting objects and sounds as well as the various forms of interaction through tracking sensors. Thus, researchers have been motivated toward the application of AR techniques under the context of assistive technology [3].

AT has shown benefits when it comes to individuals with dementia as therapeutic applications. Based on such, we present an integrated system grounded on AT through use of Mobile Augmented Reality, speech interaction and security applications. In this presentation, we show three functionalities based on our research: remind and identify the correct medicine to be taken, perform therapeutic activities through interaction with photos and objects; and tracking patient´s location if necessary.

Related Work

Assistance in daily life activities

Caregivers and individuals with Alzheimer Disease face difficulty with daily activities. Important studies have been developed using AR techniques. A study by Quintana et al [12] inserts reminders using AR markers to execute a certain task. In this study, an indoor tracker was also implemented to aid the caregiver. The study by Hervás et al [1] developed an application to assist patients with mild cognitive impairment to navigate outdoors, and also track the patient while in the outdoor environment.

Promote therapeutic exercises

Therapeutic exercises are a non-pharmacological treatment that may reduce many of the more disturbing behavioral symptoms of AD, such as agitation, anger, frustration, depression, wandering or rummaging. The collaborators in Morel et al. [9] developed a Memory Palace, a Mobile Augmented Reality application. Essentially, people take a walk through their own house, which triggers an app that memorizes their relatives. The studies in [9] use AR to assist people who have memory loss with simple everyday tasks, such as making a hot drink or cooking basic meals. In this work, they use AR markers allocated to each object in order to aid recognition and provide instructions on the display.

Figure 2. The patient asks a question. The application recognizes the spoken words and answers verbally

Differentials of the proposed system

Based on searches and user requirements (caregivers, geriatric, psychologist and physiotherapist) we consider the addition of three features. The justification for our proposal is laid out in the following subsection:

Pharmacological treatment: The studies in [2,6,8] revealed that pharmacological treatment is still the most effective way of treating AD. However, studies [5,13,15] reveal the high rate of users that forget or make mistakes when taking medication. Related work [10,13,14] developed applications to remind the user to take medication. However, the novelty of our approach is the ease of registering and recognizing medications using the very box itself. The recognition of the medication does not need to be based on the bar code or RFID. Only upon the pillbox picture.

Voice recognition: Older people are more likely to interact with voice commands than with virtual buttons [4,7]. Besides, an interface with only buttons was not intuitive and easy-to-use for users. A too many buttons interface proved to be more error-prone. Furthermore, previous work on assistance in daily life and therapeutic exercises have been proposed to assist individuals with AD using Augmented Reality. However, none of them has included a possibility to interact with the system using voice recognition, which is not a major problem for AD patients in early stages.

Locate the patient: The study in Wan et al [16] reveals the existence of problems related to the privacy for individuals with dementia. It is natural that the individual being tracked would not feel comfortable that this occurred the whole time. However, this feature is very helpful to the caregiver and it can reduce his anxiety concerning the risk of individual getting lost. In this project, we collected some requirements from the caregivers and we decided to avoid using any kind of device that the user could forget to carry (smartphones) or even remove easily (smart bands or wristwatch). So, we planned to use a small and low cost tracking device that fits onto the belt of the user. The intention is to use a device that does not disturb the user to the point of abandoning the equipment. In addition, the main difference of this application is that the caregivers can request the location by using a smartphone app and they can initiate the rescue or share the position of the patient quickly.

Proposed system

Figure 3 shows the overview of the system.

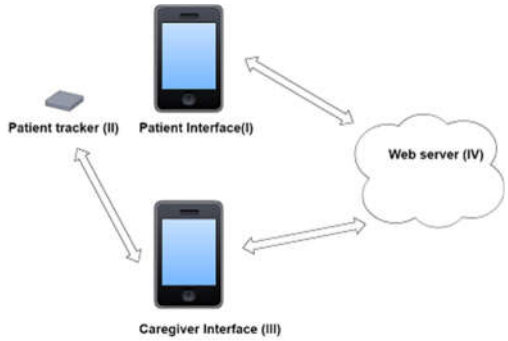

Figure 3. Overview of the integrated system

Patient Interface: This is an interface of augmented reality based on usability criteria for elderly and AD individuals in the early stages. Clean interface with large buttons with vibration feedback and speech commands are available to interact with the individual. It also has a reminder and a tracker.

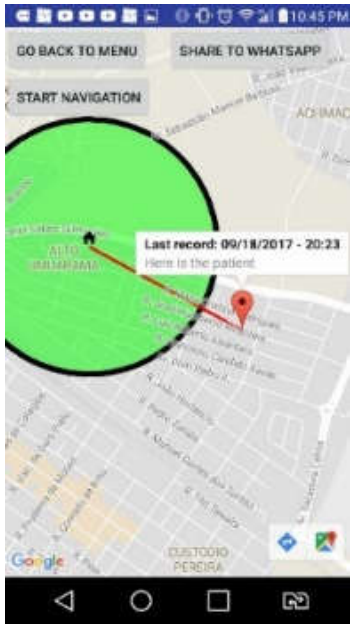

Figure 4. This interface gives the exact location of the patient and distance from their house.

Patient tracker: The tracker is a compact, discreet and lightweight device whose battery lasts for up to 72 hours. The tracker will be located on the patient's belt in a non-intrusive fashion. This tracker is responsible for issuing the patient's position from time to time or whenever requested by the caregiver. The interaction is performed through SMS (Short Message Service).

Caregiver Interface: This is a mobile device, which has interaction capabilities via SMS and internet. The caregiver can request the current position of the patient, can consult the history of activities, manage the activity schedules and adjust possible changes of data of the objects registered as markers.

Web service: a cloud web server is needed to process and integrate data within the same place. The reminders, data of AR markers, the monitoring of activities and the location of the patient are stored in this cloud web server.

Applications

Application 1: Reminder to take and identify the correct medication

The user can use this application during the early stages of Alzheimer´s disease, while also providing the caregiver with an indispensable tool. A voice alarm is triggered, informing that it is time to take the medicine. The user answers the call and is instructed to point the smartphone device at the medication. By recognizing the correct medication, a red arrow points over the medicine box and verbally informs the medication name and the amount to taken (see Figure 1). The user can ask questions concerning each medicine box registered.

Application 2: Interact with photo

The user with AD in early stages can use this app by asking questions using voice recognition (see Figure 2), providing reminders of when the picture was taken, who are the individuals in each photo, where it is, etc. In addition to the voice recognition, the user can interact with the photo using six buttons referring to the questions: what; who; why; where; when; how. This stimulates naturally the user to tell stories about each photo.

Application 3: Locate the patient

This feature assists the caregiver in locating the individual with AD (see Figure 4). Essentially, the caregiver needs to set the tracker device onto the patient's belt every day or when needed. Then, whenever the caregiver open the application, he or she can view the patient's location.

Results

We evaluated these applications to analyze their acceptability to elderly users and caregivers of individuals with AD. We also observed the use of interaction through speech recognition. We designed an experiment where participants had to perform three tasks, one for each application. Two older individuals, one former caregiver and one family member participated in the study. Until now, we have discovered the heightened efficiency generated through voice interactions on AR interfaces. The application using verbal alarms to remember and assist in locating medication were very much accepted by the evaluated users. In addition, the tracker application shows a feasibility in locating individuals in outdoor environments in a distance up to 300 kilometers.

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