The use of augmented reality to annotate the living environment of people suffering from dementia

The Ambient Notification System (ANS) uses video-based augmented reality to assist persons suffering from memory impairments. The system allows caregivers to create text-based or auditory tags by selecting objects from images captured in the home of the patient. A mobile phone, worn by the user, captures images that are sent to a server to identify tags. Once a tag is located, the user is notified of its presence through an audio cue or vibration.

There are a number of strategies that AD patients and their caregivers adopt to maintain their executive functions and independence. Placing paper tags in the home of patients with dementia is a strategy recommended to help the patient navigate the environment. For instance, the National Institute of Health in the US, include, in its list of recommendations for home safety for people with AD, placing signs such as "DO NOT TOUCH", in potentially hot appliances such as the oven or coffee maker, or placing pictures on doors of important rooms to simplify their identification. Other adaptations to the physical environment include removing cabinet doors or placing transparent plastic on drawer files to make items visible.

The Ambient Notification System aims at assisting caregivers to create textual or auditory tags on objects from images captured at the home of the person suffering from dementia. The person, for whom the tag was created, wears a mobile phone, with the camera pointing in his line of sight, which records images that are matched with a collection of photographs taken a-priory. Once an object is discovered an audio, vibration or visual cue is given to the user who can then read the tag for that object on the screen of the mobile phone, or listen to the audio note left by the caregiver.

The Ambient Notification System (ANS) has two main components, the Tag Manager, used by the caregiver, and the Mobile Notification System, used by the person suffering from dementia.

Tag Manager

The Tag Manager is used by the caregiver to define new tags by selecting the object upon which the tag will be placed and capturing the corresponding text and/or audio.

Caregivers use the Tag Manager to create and edit tags. This component provides the following basic functionality:

- Users can create and edit rooms by selecting an area over a building plan of the home of the user. Rooms are areas that are mostly closed and have limited visibility to other areas of the home.
- Users can upload photographs captured in the environment where tags can be placed. These images are associated to the room where they
were captured. At any time the caregiver can add or subtract images as the visual aspect of the room changes when furniture is added or removed.

- The user can select a room where he intends to place a tag. The system will display all the photographs associated to that room from which the user can select one that shows the object or location to which he wants to associate the tag. The system will automatically display other photographs where it recognizes the same object. The user can then select these objects to improve the tag robustness., Figure 1a shows the interface of the Tag Manager. The image in the left shows the photograph that was selected. The user draws the contour of the microwave oven, triggering the display of other images where the object is found. The area selected in these images can be modified to more closely match the object of interest.
- The system allows the user to add textual information and record audio clips to the tag. The user can also establish the period when the tag will be active. For instance, a tag indicating that a meal has been left in the fridge will be relevant only for that particular day, while another tag warning the user about opening a door might be active everyday from 8pm until 7am.

Figure 1. Tag creation. When the user selects an object of interest, the system displays other photographs where the same object is recognized.

Mobile Notification System

The Mobile Notification System runs on an Android mobile phone. It is designed to be worn by the user with the camera facing his line of view as illustrated in Figure 2a. The device constantly captures photographs that are send to a server for the detection of tags. The server runs the SURF feature detection algorithm [1] to match the database of tags with the image submitted, this is performed every two or three seconds. Approximately every 15 seconds two additional images are captured and with a set of three images the room where the user is located is estimated. This is done by
matching the features of those images with the database of photographs. Knowing the location of the user speeds the search for tagged objects.

New tags can be added at any moment using the desktop application. The Mobile Notification System checks every minute if a new tag has been added or removed, updating its database accordingly.

Several experiments have been conducted to establish the appropriate parameters to achieve an adequate balance between performance and precision. By reducing the search space to the images in the location of the user, choosing an appropriate image resolution, and searching for tags rather than objects, the system achieves near real-time performance with very few false positives. A more extensive explanation of the system evaluation can be found in [2].

We are currently evaluating the usability of the system with users that have no memory impairment, before an in-situ evaluation with users suffering from dementia is conducted. Videos of the system can be found in youtube (Tag Manager, Mobile Notification System).


[2] Quintana, E. and Favela, J. “Ambient Notifications as Memory Aids for People Suffering from Dementia” Accepted for publication in Proc. of the 5th International Symposium on Ubiquitous Computing and Ambient Intelligence (UCAmi’11), December 2011.