

Remote Assistance for Elderly to Find Hidden Objects in a Kitchen

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Abstract. Remote assistive technologies are one of the most promising solutions for an aging society in the future. This paper describes a design of a remote assistive system to guide elderly to find and recognize hidden objects in a kitchen through ubiquitous technologies utilizing sensing and light projection. These intelligent technologies can play a vital role in taking care of the elderly with cognitive impairments when the caregiver's lives or work far away. The main goal of this research is to provide visual guidance to elderly to overcoming the deficits of initiation, planning, attention and memory deficits while performing kitchen-based activities of daily living such as locating and identifying items for cooking. In a standard kitchen where objects can be placed in open and closed spaces, it is difficult for elderly with cognitive impairment to find and locate objects that are invisible and sometimes hidden behind other objects. In this situation the RFID technology can directly provide the location of the items and projection technology can display the image of the object at the exact location. An initial prototype has been developed and a user study with twelve elderly people has been conducted. The initial results show that the visual guidance makes the task of finding and identifying objects easier and simpler. Additionally, results show promise for further development and system can be used for other kitchen activities.

Keywords: Remote assistance · Elderly · Caregiver · RFID · Projection

1 Introduction

The world population is aging and people aged over 65 are increasing faster in number than any other age group [1]. In general, people of this age group prefer to live at home independently as long as possible and able to age well [2]. In fact, more than 31% people older than 65 or above, live independently within the European Union (EU) [3]. As people grow older it is difficult for them to live independently without assistance because of different cognitive and physical impairments. Caregivers reported that people with Mild Cognitive Impairment (MCI) with decreased initiation were cooking, using the

telephone, and taking medication [4]. The kitchen is the focus of this study where elderly spent most of the time doing different activities. These activities are key for their autonomy such as cooking, preparing food, storing provisions, etc. [12]. Generally, a kitchen task comprises of a set of step-by-step instructions and to complete each step requires a different kind of objects. An object can be found in an open and a closed place in a kitchen environment. Ikeda et al. [5] and Uranishi et al. [6] have developed a kitchen assistive system to support elderly by indicating with light projection visually. These systems support them to find and work with various cooking objects located in an open place such as a table top. In this work, we improve the efficiency of the elderly and caregivers to find and locate objects from not only an open place, but also hidden places such as cabinets or drawers in a kitchen. In remote assistance, it takes time to express positions and appearances of objects located in hidden places by verbal communication. In the case when a remote caregiver is guiding an elderly in an unfamiliar environment, explanations with only verbal communication take caregiver's time and increased burden.

In this paper, we present the design and initial prototype of a remote assistive system for elderly to find and recognize objects from hidden places required during a kitchen task. The system has two main features (1) find and locate the objects used during a task (2) display image of the object at the exact location of the kitchen cabinet. To achieve this goal, we utilized Radio Frequency Identification Technology (RFID) and projection technology. Our system can minimize the cognitive overhead of elderly while storing and retrieving objects from the cabinet and shelves during a task. That can also make the kitchen task more efficient and simple. Moreover, we can reduce the workload from the caretakers and by activating and encouraging the elderly in daily activities would promote independent living.

2 Related Work

There are several related works to keep track of human or objects locations. Active Bats [7] is a high accuracy ultrasound positioning system that uses ultrasonic tags on objects or person for tracking but as a disadvantage it requires a large number of ultrasound receivers around the ceiling. Another indoor location tracking system RADAR [8] use radiofrequency signals Received Signal Strength Information (RSSI). This system is easy to setup with existing Wi-Fi network with few base stations but RSSI approaches are less accurate for smaller spaces like kitchen environment.

RFID is a contact-less technology locating objects in an indoor environment and more accurate than ultrasound and infrared-based indoor tracking technologies. Moreover, battery-free passive RFID tags offer cheap tagging option with everyday objects such as cup, plates and salad bowl, etc. in a kitchen environment [9].

Moving form tracking technologies, we discuss research work developed kitchen assistive systems. Ficocelli et al. [10] developed an assistive kitchen with speech communication and automated cabinet system to help the users to storing and retrieving items, and obtaining recipes for meal preparation. But this system lacks the picture of available items and needs RFID tags to keep track the location of the required items.

Sato et al. [11] used a projector and a depth camera to designed Shadow Cooking system to guide users with step-by-step information projected on a kitchen counter. A Smart Kitchen [12] that provides ambient assisted living services, a smart environment that increases the autonomy of elderly and disabled people in their kitchen related activities. Bonani et al. [13] used augmented reality techniques in a conventional kitchen with the projection of information on objects and surfaces to help people cook more easily and safely. We combined the RFID and projection technology to help the elderly with cognitive impairment to carry out the regular kitchen activities independently such as finding and identifying objects. This system also has a remote application for the caregivers that can assist elderly remotely whenever needed.

3 Remote Assistive System

A remote assistive system has been designed using the projection technology that augments visual prompts in a kitchen environment. The design of the remote assistive system consists of two sites: a local site where the elderly is performing the task in a kitchen and a remote site where the remote caregiver is assisting. An overview of the whole system is illustrated in Fig. 1. The system starts working when an elderly in the kitchen environment is looking for an object needed in a kitchen task and the object is hidden in the cabinet. The caregiver at the remote site using an application simply selects the required object from a list of objects. The application retrieves stored objects from the database. At the local site projection system displays the image of the selected object at the exact location. Location of the object is obtained automatically. The elderly picks up the required object easily and he/she doesn't need to search out all the shelves of the cabinet.

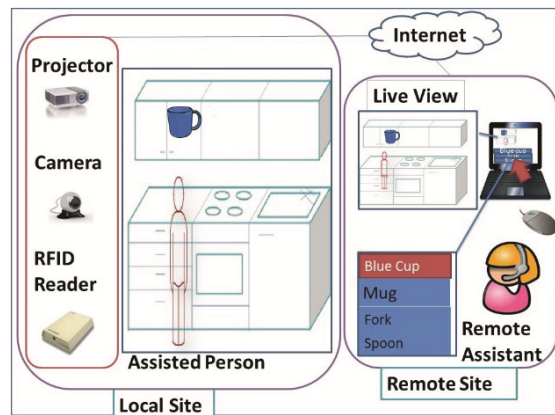


Fig. 1. Overview of the whole system: a local site where RFID and projection technology is installed to assist a person and a remote site where a caregiver using an application gives step-by-step instructions to that person via Internet.

The local site consists of a projector, camera, and an RFID system. All these tools are installed at the local site. The camera and projector attach to ceiling and pointing towards the kitchen cabinet. The projector displays the visual information on the cabinet surface and the camera only provides the live view to the remote caregiver. The live view helps the caregiver to see the real environment. Kitchen cabinet involves RFID readers in some specific shelves location. When objects with RFID tags put on these shelves, objects are detected with RFID readers. For example, if cup, glass, plates, etc. enters or leaves from the cabinet, RFID readers detects the objects. By this way, objects can be tracked on a kitchen cabinet. The remote site contains an interactive graphical interface that shows all required objects to the caregivers that assist them in any kitchen task. This application is connected via Internet to the remote site application. During a kitchen task, remote caregiver provides step-by-step instruction to the elderly using the audio connection. Remote caregiver selects the required object from the remote application and the projection system displays the image of the required object on the cabinet wall. Using this process, the elderly can easily find and locate the required object.

4 Implementation and User Study

Our prototype consists of a camera (Logitech C210 640 × 480 pixels), a projector (Epson H431B LCD 1280 × 768 pixels) and an RFID system (Takaya TR3-LN003FW4-16). We setup the proposed system in a laboratory environment. Figure 2(a) displays the camera and projector on a pole, while the RFID system is placed inside the cabinet. Figure 2(b) shows the scene from the local site with the projected image at the exact location of the cabinet. The cabinet with four shelves is shown in Fig. 2(c). The geometry between the camera, the projector, and the door surface must be calibrated in advance. The projector provides the image of the required object at the exact location and RFID reader updates the location of each object. Moreover, the camera was also intended to capture the live scene of the cabinet to facilitate remote caregiver.

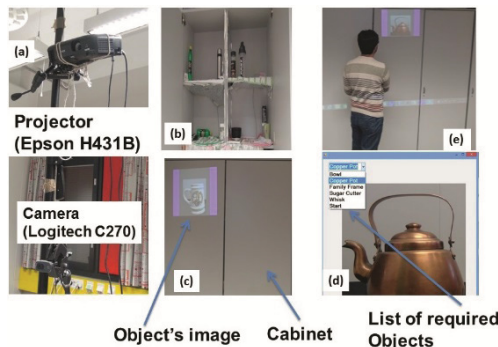


Fig. 2. (a) Our prototype system consists of a camera and a projector on the pole and RFID system placed inside the cabinet (b) the scene of the local site with the projected image (c) A cabinet with four shelves (c) Application interface used by the remote caregiver (e) live view of the local site.

The graphical user interface for remote caregiver was developed using OpenCV and MySQL database. The database is used to store the tag information attached to every kitchen object. This tag information will update the location of an object in the database automatically when an object leaves the cabinet and returns to the cabinet. The image of each object has been stored in the database along with an RFID tag. The graphical user interface lists all the stored objects used during a kitchen task. A remote caregiver using this interface selects the required object from the list and gives instruction via audio connection to the local user to pick an object from the required location. Figure 2(d) shows the interface used by the remote caregiver. After this instruction the system will show the required object at the exact location that makes the object retrieval process straightforward. Figure 2(e) shows the real scene where a person at the local site is picking an item from the cabinet. We conducted a user study with twelve elderly participants to assess the feasibility of the implemented system. All the participants performed a simple kitchen task in a laboratory environment. The task was to find and recognize objects from a kitchen cabinet. They received step-by-step instructions from the remote caregiver. Both the participants were not familiar with the kitchen environment. All the elderly participants completed the task easily and efficiently.

5 Discussion

The system is intended to help elderly living independently to locate and recognize objects from hidden places in a kitchen. The initial results show that by combining RFID technology along with the projection technology can increase the efficiency and decrease the burden of caregivers taking care of elderly people with different disabilities via Internet. Although the current prototype system uses only one projector that covers only a small area of kitchen, we can easily expand the projection area with multiple projectors. As a result of our observation, there are some limitations such as the registration of a new object when it arrives in the kitchen environment. Currently, we attached an RFID tag to each object and save it to the database before starting the actual system. To make the system more efficient in the future, the system needs to scan all the tags and register the new tag automatically. The camera can take pictures of new objects and the pictures along with the new tags can be saved to the database. In the future, we would like to compare the efficiency of our proposed system with central projection mode and with searchlight [14] system.

6 Conclusion

In this paper, we have proposed a remote assistive system that help elderly people to find objects in hidden places during a kitchen task. We implemented a prototype system with an RFID system to locate the objects from hidden places and a projector to display the image of the required object. Additionally, a user study has been conducted with twelve elderly participants in a laboratory environment to confirm feasibility of the proposed system. The initial results shows promise for the use of the system for other kitchen activities, although the user study were focusing on a small

sample of older adults. Our future work will consist of adding more features to the prototype to conduct longer studies with the larger user groups.

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