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Object Recognition-based Mnemonics Mobile App for Senior Adults Communication

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Abstract—There has been an exponential increase in smartphone usage across the globe due to decreasing production costs and a competitive marketplace. Smartphones and mobile internet services have thrived together to create virtual connections between people. However, there have been very few successful mobile apps developed for assisting senior adults in their day-to-day activities. Our research center has been developing artifacts for helping older adults. In this paper, we present the design and features of an android-based mobile app that has been developed as a mnemonics app. The app utilizes image recognition technology to trigger events using the options of calling phone numbers, sending short message service (SMS) and tweets. Caregivers and family members can map images of everyday target objects to events in the app. Subsequently, seniors can use the app to scan these objects for automatically triggering the pre-defined events, thereby saving time and effort.

Keywords—Communication aids, Mobile communication, Android app, Mnemonics aids, Senior Adults

I. INTRODUCTION

The advent of smartphones has revolutionized communication capabilities as these mobile gadgets integrate traditional telephony services with broadband internet services. Current mobile operating systems (OS) provide app development functionality for creating innovative apps which even replace desktop-based tools. Mobile phones come under the umbrella of Information and Communications Technology (ICT). ICT plays a major role in creating and sustaining an all-inclusive environment where different age-groups co-exist [1]. While there have been many ICT products, not all solutions cater to the elderly group of the population, referred to as seniors or senior adults in this paper.

Seniors comprises of people above 60 years of age as defined in [2]. With improved standards of living and better medication facilities, the percentage of this group is expected to increase and cross the two billion number mark by 2050 [3]. Therefore, there is a requirement for ICT research to concentrate on this critical demographic group. Gerontechnology is an ICT-related research area that looks at the needs of seniors, for ensuring good health, community participation and better quality of life [4].

In this paper, we present an android-based mobile app called UbiCuts (abbreviated from Ubiquitous Shortcuts). The same name has been used by our research center for a wearable

device which is also meant for seniors [5], [6]. The current mobile version is an Android smartphone-based app intended to be used as mnemonics app. It is based on the logic of associating events to physical objects that are used on a daily basis. Image recognition technology is used to identify target objects, followed by triggering of associated events. The event can be a phone call or SMS along with option of posting a tweet in the user's twitter timeline. Such events can easily be extended to other forms of communication channels in future. In the context of this app, the singular term 'ubicut' refers to a combination of a target image and its associated events. There are four use-cases in the app - creating new ubicut, editing existing ubicuts, deleting existing ubicuts and object scanning for event triggering. The initial three use-cases are handled by caregivers and family members of seniors while the last use-case is specifically for use by seniors.

The remainder of the paper is organized as follows. The next section looks at the prior studies. The third section defines the system requirements. This is followed by the outlining of technology components, design and the user interfaces of the app. The section ends with the design limitations. In the final section, the future works are discussed along with the conclusion.

II. PRIOR STUDIES

There have been studies conducted in the past to categorize the different technologies that are specifically catered for usage by seniors. CAST (Center for Aging Services Technologies) [7] have identified three technology categories - Safety, Health & Wellness and Social Connectedness. Various technologies such as fall detection units, mobility aids, cell phones, senior-friendly web applications and tele-health applications have been mapped to the aforementioned categories. Cell phones are seen as one of the preferred gadgets for ensuring social connectivity. Inmaculada et al. conducted a study [1] to specifically look at the mobile apps developed for the seniors. Apps for an important need - "Memory and daily life activity aids" are noted as necessary due to the memory decline in older adults. Such memory aids have interfaces that are minimalistic in nature so that it is easy for the seniors to learn and navigate through the app. The other elderly needs are identified as visual aids, haptic aids, features to minimize user errors and safety features [8].

With different needs to cater for, some studies have modeled social networks specifically for seniors. The EasyReach project [9] make use of Answer Set Programming (ASP) [10] to initiate conversations among senior users with respect to different events. This approach uses the power of interconnected networks to recommend other senior users in the context of a particular event (e.g. attending a church). In another related work [11], a family-oriented social network app is being developed for smart phones and tablets, targeted specifically targeted at seniors. Using this app, family members can be constantly in touch with seniors and it provides a consolidated view of the activities happening within the family.

On the topic of assistive user interfaces, Juha et al. [12] conducted a study to ascertain whether touch-based user interfaces are ideal for usage by seniors. Results indicate that seniors find touch-based interfaces as easy to learn and use. In fact, impaired motor skills don't seem to affect the continued use of such interfaces. These results are promising for pushing smart phone technology as ideal for the seniors. Smart phone apps have been developed for senior people in prior studies. Protégé [13] is an android app that helps caregivers effectively communicate with seniors. It has a comprehensive set of 16 features such as fall alert, no-activity alert, medicine alert, activity report request, to name a few. User tests conducted with the app indicate the effectiveness of the app in addressing communication gaps with senior users. eCAALYX [14] is an healthcare-based android app for seniors that makes use of a patient-wearable garments with sensors and GPS (Global Positioning System) for remote monitoring. It has been specifically designed for older patients with multiple chronic problems such as diabetes mellitus and cardiovascular diseases. The authors are cognizant that the storage capacity, processing power and size of the smart phones are some of the limiting factors while using the app.

III. SYSTEM REQUIREMENTS

A. Usage Scenarios

The systems requirements were collected by the researchers of our center, prior to the design of the app. As the app was mainly aimed at seniors, possible usage scenarios were identified after pilot interviews with one senior and three caregivers in a mature residential area of Singapore. These scenarios were later translated to requirements. The example scenarios identified are as follows:-

1) Scenario 1: Twitter update

Mr. X goes down to the Senior Citizens' Activity Centre for a singing event. He points the app at the red couch inside the meeting room of the Centre (Figure 1), and presses the scan button. A command is triggered to post a Tweet on his Twitter page, with the text "I am at the Senior Citizens Activity Centre". A voice notification is provided by the app to him on successful posting. Caregiver Mr.Y, who followed Mr.X on Twitter, receives a notification and makes note of the tweet. With the help of UbiCuts, Mr.Y would be able to receive status updates from the senior person, regarding his whereabouts and his activities.

2) Scenario 2: Making phone call

Mr X. Jr. did not visit his father last weekend, as he was very busy at work. After lunch, Mr. X wants to call his son to find out how things are going with him. Mr. X points the app at a photo of his son on the table (Figure 1), and presses the scan button. The event for calling his son is successfully triggered after the image is recognized. A voice feedback is provided as well saying: "Calling Son". His son picks up and they start the conversation.

3) Scenario 3: Sending SMS

Mr. X found there is very little rice left at home. He points the app at the empty rice container (Figure 1), and a pre-defined SMS is sent to his son, saying: "No more rice at home. Please bring back a rice pack". A voice feedback is provided for Mr. X, saying: "SMS 'No more rice at home. Please bring back a rice pack' sent to 'Son' ". Upon receiving the SMS, Mr. X Jr. goes to the supermarket to purchase the rice and delivers it to his father.

Figure 1. Sample Target Objects for the Three Scenarios

B. Identified Roles and Events

There are three roles identified from the usage scenarios. They are: the senior adult user, caregiver, and/or family member of the senior person. The senior user uses the app for scanning the objects so that the corresponding events are triggered. The other two roles are responsible for creating the ubicut objects on behalf of the senior adults group. The three roles are illustrated in Figure 2. The event trigger options identified are phone call or SMS, and a tweet option. The ubicut can either have an assigned phone call or SMS option and not both the options together as the seniors would have different priorities for a phone call and SMS with the former getting higher priority.

The key performance requirement is the speed of the image recognition technology to be used in the app. As the app is intended to be used by seniors, the app cannot take long to identify the objects. Accuracy is another important characteristic as the senior person will use the app only when it efficiently recognizes the objects without any hassles.

Figure 2. User Roles in the UbiCuts Platform

IV. SYSTEM DESIGN

A. Image Recognition Technology and Data Storage

Qualcomm's Vuforia Augmented Reality (AR) [15] service was shortlisted as the image recognition technology for the app after a short pilot project testing another image recognition service Catchoom [16]. The Vuforia service was shortlisted as it provided two advantages – the image recognition technique is based on features that depict the target objects and secondly, the target objects are stored in a cloud database managed by Qualcomm. Target objects can be stored and retrieved using HTTP API calls. The object scanning and tracking is performed using the Vuforia SDK. The SDK libraries can be embedded in the android java project.

SQLite was shortlisted as the back-end database for the app as the database engine is regarded to be simple and fast. Also, the database traffic is expected to be minimal as the ubicut creation scenario is used only on a periodic basis, thereby SQLite was an apt choice for storing the data. The data stored in the SQLite database tables are the data passed on from the user during ubicut creation, regarding the ubicut name, sms/call number, sms texts and tweet message texts. The target image id of the object is retrieved from the Vuforia and it acts as the foreign key connecting the Vuforia cloud storage and the SQLite database.

B. System Architecture

The system architecture of the UbiCuts app is illustrated in Figure 3. There are three major sections in the overall architecture – the Smart phone components, UbiCuts internal modules and External data components. The smart phone components used in the app are the camera, contact list, the SMS feature and the call feature. Additionally, the thumbnail of the target image is stored in the phone in a folder with the name 'ubicutupload' under the root directory. There are four internal modules in the UbiCuts app. They are the four basic CRUD (Create, Read, Update and Delete) functions of persistent storage [17] for handling ubicut objects. The external data components in this app are Twitter and Vuforia AR service. The transactions with these two services are HTTPS-based. The Twitter4J API library [18] is used for creating twitter sessions, in order to post tweets. As mentioned earlier, all the calls to Vuforia service are made through APIs with the exception of target object tracking where the SDK is directly used. User Interface

C. User Interface

1) Use-case 1: Create New Ubicut

In this use-case, the objective of the user is to create a shortcut with a target object and the corresponding trigger events. The first step is to launch the UbiCuts app. In the home screen, the user has to click on the 'Create New Ubicut' button. The camera preview screen opens once the button is clicked. In this screen, the user has to focus the camera on the target object and click on the 'Capture Image' button. The app sends the captured image to the Vuforia cloud service for checking the image rating. The rating of an image ranges from 0 to 5. The value 0 means there are no adequate features while 5 means there are more features than expected.

Figure 3. UbiCuts System Architecture

The app receives the image rating after approximately 35 seconds from the cloud. If the rating is below 1, the app displays the error message 'Poor image quality. Please try again'. Three attempts are provided to the user. If the three attempts are exhausted, the app moves back to the home screen.

If the rating is at least 1, the app moves to the screen where the user has to enter the details for the particular ubicut. The first step is the name of the ubicut. The second step is the selection of the trigger events checkboxes. The three options are call, SMS and tweet. Based on the selected options, the appropriate dialogs are displayed to the user for getting the phone numbers and message texts. After the requested details are provided, the user can preview the information in a review screen. If satisfied, the button 'Create New Ubicut' activates the app to save the data in SQLite database and immediately starts a background thread to check the upload status of the target image in the Vuforia cloud. This thread is re-run every 30 seconds. Once the image is successfully uploaded in the cloud, a notification is flashed to the user with the message 'The target image has been uploaded in the cloud'. The screenshots of the above mentioned steps are depicted in Figure 4.

2) Use-case 2: Edit Existing Ubicut

The edit ubicut use-case is provided to the user to update certain details of an existing ubicut. For starting this use-case, the user starts by clicking on the 'Edit Existing UbiCut' button on the home screen. The list of ubicuts is displayed in a list view in the next screen. A confirmation dialog is displayed to the user when an ubicut task is selected. On pressing the OK button, the next screen is displayed with the details of the selected ubicut. The target image, ubicut name, phone numbers and message texts are displayed in this screen. If the user wishes to update the target image, the button 'Update target image' is to be clicked. The camera preview screen is opened if the button is clicked. Otherwise, if the user intends to change the phone numbers, message texts or change the event from SMS to call or add the tweet event, the necessary actions can be performed in the screen itself. Once the user is satisfied with the data, the button 'Update Task' is to be clicked. The app

displays a success message as a confirmation of the activity completion. The screenshots of the above mentioned steps are depicted in Figure 5.

Figure 4. UI Screens for Create New UbiCut Use-case

Figure 5. UI Screens for Edit Existing UbiCut Use-case

3) Use-case 3: Delete Existing Ubicut

In the 'edit ubicut' screen, the option of deleting the ubicut is also provided. There will be scenarios where the user wants to discontinue the use of an ubicut for personal reasons. The user can accomplish the activity by clicking the 'Delete Task' button. Once the button is clicked, the ubicut data is instantly deleted in the SQLite database. An API call to de-activate the target image in the Vuforia cloud is also made. A confirmation dialog is displayed to the user on the completion of the activity. The UI screenshot for this use-case is depicted in Figure 6.

Figure 6. UI Screen for Delete Existing Ubicut Use-case

4) Use-case 4: Scan Target Objects

This use-case is the only use-case that is to be used by the senior user. In the home screen, the spherical button 'Start Scanning' is to be clicked to initiate the use-case (refer the first screenshot Figure 4 for the home screen). In the next screen, the camera preview is displayed along with a feature tracking service. This service looks for recognizable features in the target image being covered. If the recorded features of the target images in the cloud matches with the recognized features in the camera preview screen, Vuforia service sends the target id to the app. The app uses the target id to locate the ubicut in the SQLite database. Once the ubicut is located, the corresponding trigger-events are retrieved. If the event is call event, the telephony service in the phone is invoked and a call is made to the recorded phone number.

If the event is SMS event, SMS with the retrieved text is sent to the corresponding phone numbers. On the initiation of the SMS event, the app gives a voice notification to the user in the format 'An SMS with the text <text message> has been sent to <phone number>'. If the event is tweet event, a twitter session is invoked and the tweet is posted with the specified text. Similarly, a voice notification is provided to the user in the format 'A tweet with the text <text message> has been posted'. Once all the expected events are triggered, the user can close the app or go back to the home screen. The UI screenshot for this use-case is depicted in Figure 7. The green dots in the figure represent the features in the physical objects, recognized by the Vuforia AR service.

Figure 7. UI Screen for Target Scan Use-case

D. Design Limitations

UbiCuts has certain design limitations that are to be stated so that potential users are aware of the issues. The limitations are provided in Table I.

TABLE I. UBICUTS LIMITATIONS

S/No	Limitation
1	Plain objects such as walls, bottles/containers with no stickers or any object which has a single color pattern will not be recorded as an ubicut object due to lack of adequate features.
2	If there are any other unnecessary objects in the background when an image of the target object is captured, the features of those objects might also be recorded during ubicut creation. Therefore, these unnecessary features can potentially hamper the target scanning process.
3	The features present in the particular view of a target object will only be captured. The app does not capture the features from all possible views such as top view, side view or a front view.
4	If there is a lack of natural lighting, objects will not be recognized during target scanning. Same scenario applies during ubicut creation as well since features of the target object will not be recognized due to lack of sufficient light for the camera.

V. CONCLUSION AND FUTURE WORK

The number of seniors has seen a steady increase in many societies and this trend will continue in the future due to improved living conditions. There is a necessity to sustain a harmonious society for people from all age-groups, and communication devices, in order to be inclusive, need to be targeted, identify and recognise the unique needs of different users. ICT-based research should be used for this purpose. In this paper, we presented a mnemonics-based android app called UbiCuts for helping seniors with their daily communication needs. This app will help seniors in completing their day-to-day activities of contacting their family members and also for providing necessary updates to caregivers.

Our next phase of work is to test and validate the app with different profiles of senior adults across the country. Some of the differences in these profiles are caused by factors such as affluence level, living arrangements and nuclear/extended family structures. The image recognition feature in the app will be enhanced to capture/recognize objects in different lightings. A viewport box in the camera preview screen will be included

so that the users are able to frame the target object properly within the box. There are also plans to develop a smartwatch version of UbiCuts so that it is even more convenient for the user.

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