Teleassistance in Accessible Shopping for the Blind

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Abstract

In this paper, we present TeleShop, the teleassistance module of ShopMobile 2, our mobile accessible shopping system for visually impaired (VI) and blind individuals that we have been developing for the past several years. TeleShop enables its users to obtain help from remote sighted guides by transmitting images and voice from their smartphones to the guides' computers or phones. We have successfully tested TeleShop in a laboratory study in which a married couple (a blind husband and a sighted wife) used it to retrieve grocery products and read nutrition facts from product packages.

1 Introduction

We are developing a mobile shopping solution, ShopMobile 2, which allows VI shoppers to shop independently using only a smartphone [1, 2]. ShopMobile 2 has three software modules: an eyes-free barcode scanner, an optical character recognition (OCR) engine, and a teleassistance module called TeleShop. The eyes-free barcode scanner allows VI shoppers to scan UPC barcodes on products and MSI barcodes on shelves. The OCR engine will allow them to read barcode labels and nutrition facts on products. TeleShop allows VI users to obtain assistance from remote sighted caregivers by transmitting images and voice from their smartphones to the guides' computers or phones. TeleShop provides a backup in situations when the barcode scanner and OCR engine fail or malfunction. There is research evidence that having sighted guidance reduces the psychological stress on VI individuals [3]. TeleShop can provide the equivalence of sighted guidance without requiring the guide to be physically present.

The remainder of the paper is organized as follows. Section 2 presents an overview of existing assistive grocery shopping and navigation systems. Section 3 describes the TeleShop module of ShopMobile 2. Section 4 describes our laboratory study. Section 5 offers our conclusion and thoughts on future work.

2 Related Work

2.1 Assistive Grocery Shopping Systems

RoboCart [4, 5], ShopTalk [6], ShopMobile 1 [7], GroZi [8], iCare [9, 10] and Trinetra [11] are some examples of assistive shopping systems. RoboCart was developed by researchers at our laboratory at Utah State University. Shoppers followed a Pioneer 2DX robot equipped with a laser range finder and RFID reader to arrive in the vicinity of products where they used a hand-held barcode scanner for product identification. ShopTalk and ShopMobile 1 were developed at our laboratory. ShopTalk used an OQO computer connected to a wireless handheld barcode scanner and keypad; ShopMobile 1 used a smartphone connected wirelessly to a Baracoda pen barcode reader. In both systems, shoppers would scan MSI barcodes on shelves to obtain directions to target products and UPC barcodes on products to verify that they have picked the correct product.

GroZi was developed at UCSD. The system employs a custom device known as a MoZi box that contains a camera and a haptic feedback mechanism. To use the system, the VI shopper enters the aisle and points the MoZi box towards the products. The MoZi box collects images of products and compares them with images in two databases to locate target products and guide users towards them. iCare was developed at Arizona State University. The system is based on the assumption that products are tagged with RFID tags. Shoppers use a RFID reader embedded within a glove to locate products. Trinetra is a CMU system that uses a Baracoda pen barcode reader and a RFID reader connected to a Nokia smartphone. Shoppers can use the barcode reader to scan barcodes and the RFID reader to scan RFID tags on products when and if those tags become available on products.

2.2 Assistive Navigation Systems

Human navigation can be classified in to two categories - *micro-navigation* and *macro-navigation* [12]. Micro-navigation involves tasks in immediate vicinity of the traveler like obstacle avoidance. Macro-navigation involves tasks outside of the immediate perceptible environment. Planning a path between two points, looking for landmarks and waypoints are examples of macro-navigation tasks. VI travelers perform both tasks continuously.

VI travelers typically use long canes or guide dogs to handle micro-navigation tasks. However, sophisticated devices such as sonar canes and optical systems such as the Tom Pouce [13] or the TeleTact [13] system may also be used. Long canes can detect obstacles in front of the traveler from the ground up to waist height but are unable to detect overhanging obstacles or obstacles at head height. Sonar based systems cannot detect small obstacles while optical based systems do not perform well in areas glass surfaces.

GPS based systems [14, 15] are broadly used to assist VI travelers with macro-navigation. However, since GPS solutions do not work well indoors, some researchers resort to other methods, such as RFID [16] for indoor navigation. Vision based systems can also be used for indoor navigation. The system described in [17] places fiducials next to barcodes, which can be decoded with a cell phone camera. Another vision based system is Google Goggles [18]. Using this system, the VI traveler can capture an image using her cell phone and Google Goggles can automatically decode text from it or match it with other images in its database. While this approach may be the right way to go in the long term, the system is currently not too reliable.

2.3 Teleassistance

The term *teleassistance* covers a wide range of technologies to enable VI individuals to transmit video and voice to remote locations to obtain assistance which is typically given through voice. The systems developed by Bujacz et. al. [19] and by Garaj et. al. [12] are but two examples of such systems. The system developed by Bujacz et. al. uses two notebook computers - one is carried by the VI traveler in a backpack and the other used by the sighted guide. The VI traveler transmits video through a USB camera mounted on the chest and connected to the computer. A earphone and microphone headset are used for communicating with the guide. The authors conducted indoor navigation trials and found that VI travelers walked faster, at a steadier pace, and were able to navigate easily when assisted by remote guides. The system developed by Garaj et. al. uses a GPS receiver in addition to the camera and notebook computer. Communication is established by using two GSM cell phones - one for voice and one for transmitting GPS data and a UHF link for transmitting video. The sighted guide can view the VI traveler's position on a map obtained from a GIS database in addition to the images from the camera. They conducted an outdoor trial and tested both the micro-navigation and macro-navigation functionality of the system. They found that mobility levels for VI travelers increased when they were aided by sighted guides as compared to traveling unguided.

3 TeleShop

The TeleShop module of ShopMobile 2 consists of a server running on the VI shopper's smartphone and a client running on the caregiver's computer. As shown in Figure 2, images from the phone's camera are continuously transmitted by the server to the client and subsequently displayed on the GUI shown in Figure 1. The client allows the user to start, stop, and pause the incoming image stream and to change image parameters like resolution and quality. The pause option allows the caregiver to hold the current image on the screen when she wants to read something in the image. Changing the image parameters allows the caregiver to choose between the level of detail in the image and the smoothness of the incoming image stream. Images of high resolution and quality provide very good detail but may cause the resulting video stream to be choppy. On the other hand, images of lower resolution and quality result in a smoother video stream but do not provide much detail. The remote guide is given the option to choose the settings that suit her best.

All communication occurs over UDP. The VI shopper inputs the IP address and port number of the client to the server, which uses it to transmit images to the client. The client can retrieve the IP address and port number of the server from the incoming packets and uses it to transmit image parameters to the server. The client's information was input on the server because the client's IP address stays the same whereas the server's IP address can change if it is on a 3G network. TeleShop can operate with WiFi or 3G.

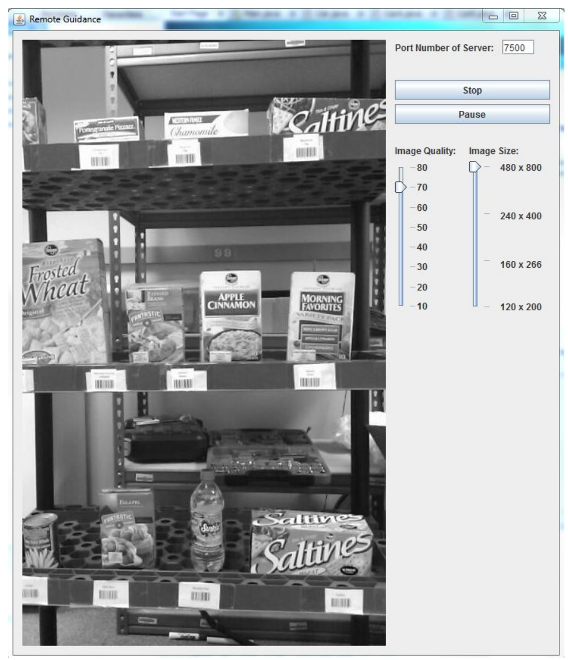

Figure 1: Screenshot of the Client.

4 Laboratory Study

Two laboratory studies TeleShop were conducted. The first study was done with two sighted students, Alice and Bob. The second study was done with a married couple: a com-

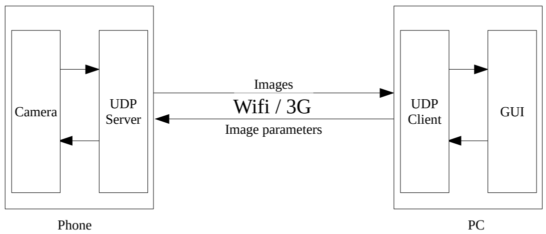

Figure 2: Overview of Communication Between the Server and the Client.

pletely blind person (Carl) and his wife (Diana). All names have been changed to protect privacy. For both studies, we stocked four plastic shelves with empty boxes, cans, and bottles to simulate an aisle in a grocery store. In both studies, a Google Nexus One smartphone ran the TeleShop server and transmitted images and voice over WiFi to the remote guide's laptop with the client software in a different room.

In the first study, we blindfolded Bob so that he could assume the role of a VI shopper, and Alice assumed the role of the sighted guide. Alice was trained to use the client GUI, and Bob was trained to use the cell phone. A voice link was established between the two by making a regular call. Once both of them were comfortable with the system, Alice was given a list of nine products (three sets containing three products each), which she had to help Bob shop for. Bob used the smartphone to transmit images of the shelf and Alice helped him pick the target products. When a target product was found, Alice would help Bob align the product with the camera so that she could read the nutrition facts from the product's package. She would then read out the nutritional facts on the product to Bob before moving on to the next product on the list. The second laboratory with Diana and Carl used the same training and settings.

Both teams were able to retrieve and read nutrition facts from all the nine products successfully. Figure 3 shows the times taken to retrieve products and to read the nutrition facts of each product for both teams. It must be noted that product six did not have any nutrition facts on it and so the times taken to read its nutrition facts are zeros. Alice and Bob took an average of 57.22 and 86.5 seconds to retrieve a product from the shelf and to read its nutrition facts, respectively. The corresponding times for Carl and Diana were 19.33 and 74.8 seconds respectively [20]. The times taken to read the nutrition facts are greater than the times taken to retrieve products. To read the nutrition facts, the VI shopper had to align the product so that its nutrition table faced the camera, which took considerable time for both teams. It was observed that communication between the VI shopper and the sighted guide were key for quick retrieval and alignment of products. This may be the reason why Carl and Diana, being a married couple, were able to retrieve products and read nutrition facts faster than Alice and Bob. It was also observed that Alice did not change the resolution and quality settings at all whereas Diana changed it several times.

During the post-experiment informal interviews, Alice said that she was comfortable with the default resolution and size settings and did not need to change them. Both teams also said that they were comfortable with the system and did not have any problems with it. Diana suggested that allowing her to rotate the paused image would help with reading the nutrition facts. When asked about using this system in real-life, Carl said that he would find this system very helpful. He mentioned that when he travels, he uses Skype from his laptop to video call his wife to get information about the layout of his hotel rooms. The TeleShop module would allow him to get the same assistance more easily.

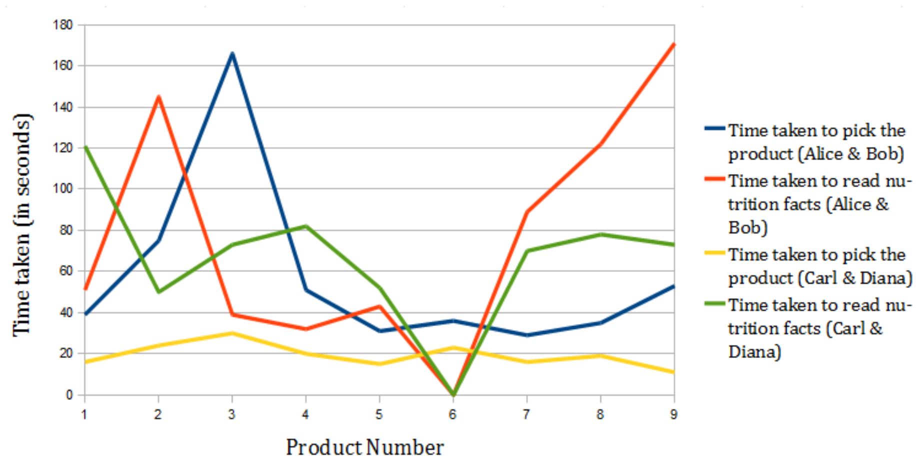

Figure 3: Times Taken to Retrieve Products and Read Nutrition Facts on Products.

5 Conclusions and Future Work

We have presented Teleshop, the teleassistance module of ShopMobile 2, our accessible shopping system for VI and blind individuals. TeleShop enables VI individuals to obtain help from remote sighted guides by transmitting images and voice over wireless connections. Two laboratory studies conducted with the system have demonstrated that it is possible for blind and blindfolded shoppers to retrieve products and obtain their nutrition information. Currently, this system simulates a video feed by transmitting images. In future, we would like to replace it with a real-time video streaming protocol such as RTSP. We would also like to develop client applications that can run on smartphones in addition to laptops and desktops.

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