VOLUME 5 NO. 1
JUNE 2008
ISSN 1675-7017

SOCIAL AND MANAGEMENT RESEARCH JOURNAL

RESEARCH MANAGEMENT INSTITUTE

Social and Management Research Journal is jointly published by Research Management Institute (RMI) and University Publication Centre (UPENA), Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

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Vol. 5 No. 1 **June 2008** **ISSN 1675-7017**

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Grocery Shopping Assistant for Visually Impaired

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ABSTRACT

Providing a great shopping experience to shoppers is the most competitive strategy taken by every grocery owners. They are striving to satisfy the growing demands of today's savvy shoppers. Unfortunately, most of the grocery owner is not actively pursuing a solution to create an independent shopping environment to their customers who are blind and visually impaired people. The information printed at the grocery items make shopping independently impossible for the blind and very difficult for visually impaired people. This sensory capability limits their shopping activities in identifying items at the grocery store. There are many kinds of grocery items that can be identified by the means of touch or smell such as vegetables and fruits, but it is a challenging effort to differentiate packaged items. Therefore, blind shoppers must rely on assistance from sighted individual or grocery store employee to help them in getting the exact items which may be burdening and a waste of their time. This situation will restrict the independence movement of the blind shoppers. The Grocery Shopping Assistant was created to assist the blind in identifying grocery items during shopping using Radio-frequency Identification (RFID) and text to speech technology. The blind only need to touch the RFID tag attached at the grocery item to the RFID scanner. The necessary product information regarding the item will be extracted from the database based on the primary key. This text-based information will be converted into a voice-based and push to the user's hand phone via Bluetooth technology. The implementation of this system allows blind people to shop as efficiently and safely as anyone else without having to rely on anyone. This study also

ISSN 1675-7017

investigates user satisfaction of the system. The result exhibits that the users are very impressive with the shopping independence that this system can offer them.

Keywords: *Radio-frequency Identification, RFID Tag, RFID Reader, Passive RFID Tags, Active RFID Tags*

Introduction

Shopping has become one of the common public activities which should be considered as a routine activity. With the convenient shopping experience provided by most stores, the customer will have a great experience, and they are likely to come back. This phenomenon has made every owner of the grocery store realize the importance of providing an ultimate convenient grocery shopping experience to their customer. But, there are not many grocery stores that provide an independent shopping experience to the blind and visually impaired people. According to Hopkins (2000), the term visually impaired is generally used to describe all those who have a seeing disability that cannot be corrected by glasses. A blind person can be registered as either blind or partially sighted based on the quality of distance and side vision as measured by consultant ophthalmologists (Hopkins, 2000). Normally, these people also have difficulty in reading or unable to read letters of regular print.

Blind people lose some part of their independence and mobility in their activities. Even a daily activity such as shopping at the grocery store requires them to be assisted by a sighted person. There are many types of grocery items especially foods that can be easily identified by means of touch or smell such as vegetables and fruits. But it is harder to identify grocery items such as bottles of ketchup, canned beans, cereal boxes, or packets of biscuits. This creates a common problem for the blind people to difeerentiate a packaged item from one with the same shape of container but have different contents. Thus this situation will invite a very serious problem to the blind people if they fetch products which are poisonous and hazardous. The blind people must rely on assistance from sighted individuals or grocery store employees to assist them in identifying and describing the grocery item which they hold during shopping. This situation will burden both parties besides taking up more of their time. Shopping online also is not an easy task for this group, who need to use screen-reading software to listen to what is being read out from the computer screen. Coyne and Nielsen (2001) estimated that the web is about three times easier to use for sighted users than it is for users who are blind or who have low vision. All these problems will contribute to less independence among blind shoppers.

Therefore an alternative technology which will assist the blind people to shop in a grocery store is needed to improve their shopping experience and quality of life. The Grocery Shopping Assistant is developed to assist the blind and visually impaired people in identifying grocery items during shopping using RFID and text to speech technology. The implementation of the Grocery Shopping Assistant is limited to a small grocery store which consists less than a thousand of selected items. The RFID reader will use a short range passive tag with limitation of practical distances ranging from 0 to 10 cm. The Grocery Shopping Assistant gives an independent shopping experience among the blind shoppers when they are able to locate and search the products on their own. As a matter of fact, this technology will allow faster and accurate identification, without requiring assistance from sighted person during the time of identification. The Grocery Shopping Assistant is more economical compared to applying braille tags on every stocked item in a grocery store. Furthermore, the implementation of technology does not required blind people to bring along big equipment to assist them in identifying grocery items during shopping.

Aligned to the above problem, the objectives of the study had been identified as follows:

a. To develop a Grocery Shopping Assistant integrated with RFID technology for the blind and visually impaired people.
b. To study the effectiveness of the Grocery Shopping Assistant.

Theoretical Background

Radio frequency identification (RFID) is a technology that is seen as a future replacement for barcodes on products and has been accepted by the manufacturers and retailers. This technology uses radio waves to identify people or objects. There are several methods of identification, but the most common is to store a serial number that identifies a person or object on a microchip that is attached to an antenna. The chip and the antenna together are called an RFID transponder or an RFID tag. The antenna enables the chip to transmit the identification information to the RFID reader. The reader converts the radio waves from the RFID tag into digital information that was passed on to computers or system to process it. An RFID system consists of two main components, RFID tag and RFID reader. RFID tag is also call as RFID transponder and it is usually attached to the object to be identified and carries information in an electronic microchip. The RFID reader then detects tags and performance read/ writes operations on RFID tags. RFID technology has active RFID tags and passive RFID tags, which are fundamentally different technologies. Active RFID tag has an internal power source or battery. The battery can be used as a partial or complete source of power for the tag's circuitry and antenna, and may

have longer range and larger memories than passive tags. It also has the ability to store additional information sent by the transceiver.

Hedgpeth et al. (2008) presented a prototype system called iCARE with wireless solution as the assistive technology to help people with visual impairments in shopping with complete independence and offers an unique feature of letting them browse the shelves without having to stick to a pre conceived shopping list. The shopping assistant has two major components to it. The first is a mobile computing device, typical PDA, with Bluetooth and Wi-Fi capabilities, and loaded with a screen reading software. The second component consists of a Bluetooth enabled Radio Frequency Identification (RFID) reader that is embedded into a hand glove. Lanigan et al. (2006) has developed a cost effective assistive technologies to increase the quality of life for the blind by harnessing the collective capability of diverse networked embedded devices to support navigation, grocery shopping, transportation and others. The blind will scan aisles which are equipped with RFID tag using Baracoda IDBlue-RFID scanning pencil and Baracoda barcode scanning-pencil that is then sent via Bluetooth to Trinetra Symbian C++ application residing on the mobile phone. En-Vision Amerika (2006) introduced the I.D. Mate product, a talking barcode scanner which is specifically targeted for blind users. The product is a portable, electronic device that scans barcodes and labels of various items at the grocery store. On board the device is a UPC database of almost 1 million items to enable the identification of scanned items. Kulyukin et al. (2004) described how radio frequency identification (RFID) can be used in robot-assisted indoor navigation for the visually impaired. They presented a robotic guide for the visually impaired that was deployed and tested both with and without visually unpaired participants in two indoor environments. They modified the standard potential fields algorithms to achieve navigation at moderate walking speeds and to avoid oscillation in narrow spaces. The experiments illustrated that passive RFID tags deployed in the environment could act as reliable stimuli that trigger local navigation behaviors to achieve global navigation objectives.

Kulyukin et al. (2008) designed a proof-of-concept prototype of a robotic shopping assistant for the visually impaired called RoboCart. The purpose of RoboCart is to help visually impaired customers navigate a typical grocery store and carry purchased items. For localization, RoboCart relies on RFID tags deployed at various locations in the store. For navigation, Robo-Cart relies on laser range finding. Parente & Bishop (2003) introduced Blind Audio Tactile Mapping System or BATS that focuses on helping students with visual impairments access and explore spatial information using standard computer hardware and open source software. The work is largely based on prior techniques used in presenting maps to the blind such as text-to-speech synthesis, auditory icons, and tactile feedback.

En-vision Amerika (2006) had developed ScripTalk where it is a talking medication-label system that exploits radio-frequency identification (RFID) technology to tag and later identify prescription drugs for visually impaired individuals. When a ScripTalk user submit a prescriptions to a pharmacy, the pharmacy uses a special ScripTalk software and a custom printer to generate and affix an RFID label containing information such as patients name, drug name and others.

Methodology

This study was conducted in six phases. Planning was the first phase where some feasibility study was done to determine the scope, objectives, significance and specification of the research. In this phase, a study was done to determine any possible constraints regarding the research. The second phase was the analysis phase which was accomplished by doing an analysis of primary and secondary study. The primary study concentrated on the user needs of the system which had been gathered through a survey done among the blind people. While in secondary study, previous efforts were reviewed from journals, articles, books and Internet resources to get a better view of the problems and the study itself. The hardware and software requirements were also identified at this stage. In the design phase, the architecture of Grocery Shopping Assistant was designed, whereas in development phase, the system was developed and coded using PHP language for scripting, and MySQL for its database. The fifth phase was when the system was tested in real environment to ensure its performance and integrity. After the phase was complete, the system was tested and evaluated in a real environment based on the user behavior and satisfaction on Grocery Shopping Assistant through a survey conducted on the same sample of blind people. Shoulsd any problem arose, some modification and alteration would be done. If there were no problems, the final version of code would be written and the system was then ready to be implemented.The maintenance phase was an on-going process that deals with any changes that needs to be made to fulfill the objective.

The Grocery Shopping Assistant employs an off-the-shelf radio-frequency technology that enables the user to shop and gets product information independently. The system uses text-to-speech software to tell the user the price of item he or she holds in a store. The product information such as product ID, price and brand is stored in a database, which will be referred when the RFID reader identifies the RFID signal from the product's tag. If the product information existed, it will be pushed to the user's mobile phone or Bluetooth handheld devices via Bluetooth technology. The information was converted from text-based into speech using text to speech system, before push it to the handheld

device. If the information does not exist, a "no product found" message will be conveyed. Figure 1 shows the architecture of Grocery Shopping Assistant.

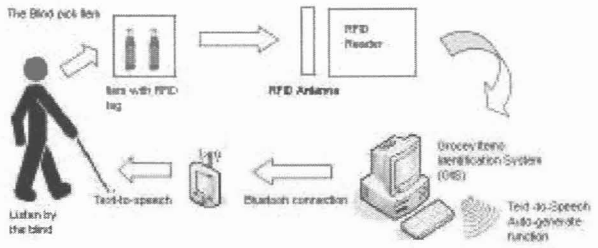

Figure 1: The Architecture of Grocery Shopping Assistant

The interview sessions were conducted at the Offices of the Malaysian Association for the Blind (Persatuan Bagi Orang-Orang Buta Malaysia), located at Jalan Brickfields, Kuala Lumpur, Malaysia and also at Section 13, Section 18 and Section 19, Shah Alam, Selangor, Malaysia. From the 17 total respondents, 12 of them were aged between 20 to 30 years old, 2 aged between 30 to 40 years old, and 3 aged between 40 to 50 years old. About eight questions related to the satisfaction on Grocery Shopping Assistant had been asked.

Results and Findings

This section discusses on the analysis results that had been gathered from the interviews conducted in relation to the satisfaction of the blind person on Grocery Shopping Assistant. There were two categories of analysis that had been done. The interview based on the effectiveness of the blinds to identify grocery items before testing Grocery Shopping Assistant, and after testing Grocery Shopping Assistant. Table 1 shows the first analysis, based on the interview that was done before testing Grocery Shopping Assistant, and table 2 shows the second analysis, based on the interview that was done after testing Grocery Shopping Assistant.

Discussions and Conclusions

Independence in one's daily activities is the topmost priority for the blind people; a completed task without requiring or requesting assistance from a sighted person would be invaluable. Daily activities such as grocery shopping and identifying items are still causing problems to the blinds. Furthermore, a common problem for blind and visually impaired people is to differentiate between

Table 1: Analysis of Interview before Testing Grocery Shopping Assistant

Question	Findings
1. Do you face any problem in identifying grocery item?	100% of the respondents faced problems in identifying grocery item during shopping.
2. Usually, how do you identify the grocery item?	65% of them identify grocery items by using the senses of smell and touch. While only 35% use different techniques such as shake and hear the sound of object movement to ensure that they had choose the right items.
3. Usually how do you overcome the problem of identifying items?	53% of blind people asked for assistance from their family members, 35% asked assistance from grocery store employee, while 12% guided by others such as other customers at grocery store in choosing items during shopping. Normally this assistance includes with guides, identifies and fetches the right items by sighted (normal) person.
4. Do you have any gadget or application to help you identify grocery item?	None of the respondents use or own any gadget for helping them in identifying grocery item correctly.
5. Normally how long do you spend your time to identify each item?	76% of the blinds people responded that they have to spend more than 5 minutes to identify each item, while 6% have to spend more than 10 minutes. However, 18% of the respondents claimed they are able to identify an item in less than 5 minutes, but they have to use many techniques to identify each item such as touch and shake.
6. Is it hard for you to differentiate between containers that feel the same but have different contents?	100% of them responded, it is hard to differentiate containers that feel the same but have different contents because sometimes the containers are of the same size and weight.
7. Do you feel burden by asking for assistance from sighted person during grocery shopping?	82% of the blind feel burden to ask for assistance by sight person during grocery shopping. While 18% feel comfortable to get assistance from sighted person.
8. Do you feel that you had lost your confidence when asking for a help from sighted person?	71% of the blinds agree that they had lost confidence when asking for help from sighted person. While 29% feel they did not lost any confidence to ask a help from sighted person.

Table 2: Analysis of Interview after Testing Grocery Shopping Assistant

Question	Findings
1. How long do you spend to identify an item?	94% of respondents spend less than a minute to identify each grocery items. While only 6% of the respondents spend more than a minute to identify item.
2. Do you understand the output that spoke out through the hand phone's speaker?	88% from the respondents understand the Grocery Shopping Assistant output which consist of text to speech. While only 12% did not understand the output since it was in English language.
3. Do you feel that Grocery Shopping Assistant is really help to identify grocery item and Do you agree if Grocery Shopping Assistant is implemented in grocery store?	94% of the respondents answer yes. This means most of them agreed that Grocery Shopping Assistant is really helping them to identify grocery items. Besides, they also agreed if Grocery Shopping Assistant is implemented in grocery store in order to increase their independence.

containers that feel the same but have different contents. In consideration of these problems, the Grocery Shopping Assistant is designed to help the blind identify the items without much difficulties. The Grocery Shopping Assistant provides RFID technology for the blind to identify grocery item. Besides, text to speech output is also implemented in order to let the blind clearly understand and know what kind of item he is holding. The implementation of technology for the blind people can offer additional independent shopping experience for the blind. The blind shopper need not ask for assistance from someone else, and they are able to identify the products which they are holding on their own.

In order to improve this study, there are several areas that have been recognized as recommendations for future enhancements. Grocery Shopping Assistant only covers for the blinds to identify items which they are holding. However, it does not assist the blind to navigate the right isle or rack. It is hoped that future study will be done to help the blind navigate to the right location to access the item. This study only used RFID device with passive tags that can only be detected by RFID reader practical distances ranging from 0 to 10 cm. It is recommended that the higher range of RFID device be used in the future to overcome the limitation of practical distance range of signal. In most circumstances, tags transmitting their ID in the same time slot cannot be detected. In a stochastic anti-collision algorithm there is hence always a chance that a tag is not detected for at least the duration of a single frame, if more than a single tag is present. Obviously, the probability of collisions decreases with the number of available time slots and increases with the number of electronic tags present. It is recommended to the future researcher to design better text to speech engine in order to increase the system's performance. Besides, this will

ensure the satisfaction among the end users. The existing system still has the weaknesses since not all of the words can be spoken clearly. Thus, it is a hope that future system will increase the clarity of text to speech application.

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