Indoor Navigation and Product Recognition for Blind People Assisted Shopping

R. Sriniketa, Shrikara Hathwar, K. S2, Vadiraj3, B. R. Vatsala4, Dr. C. Vidyaraj5
Department of Computer Science and Engineering
The National Institute of Engineering, Mysuru, India

Abstract:
Nowadays, with the rapid development in the field of mobile technology, different IT based assistive technologies have been developed in order to provide a better quality of life for people who have special needs such as visual impairment. These technologies have contributed mainly to helping blind people to interact efficiently with social activities and increasing their ability for having independent lives. This is can be seen through different applications that used for path guiding, obstacles detection, searching and identifying objects. There are a lot of challenges that face visually impaired people in performing their daily tasks especially accessing information about surrounding objects. For this reasons, there is an increasing interest in developing effective solutions that can help them in recognizing any objects. These solutions were designed using different technologies such as image processing, which includes optical character recognition (OCR), color identifiers, brightness identifiers and objects recognitions algorithms. Furthermore, barcode, RFID (radiofrequency identification devices), tactile signs and Braille have been used for wide range of applications. Our proposal, namely Blind Shopping, addresses the above mentioned requirements to provide an inexpensive and feasible solution in order to ensure wide deployment from blind people and supermarket organisations. A remarkable feature of our solution is that blind people will follow the conventional shopping behaviour somebody without visual problems.

Keywords: blind people, Shopping, supermarket, product identification, barcode scanner.

I. INTRODUCTION

Although technology seems to be invading every aspect of our lives, it is still having limited impact on those social collectives which most need it, i.e. dependable people due to sensorial impairments or advanced age. One of the concrete application domains targeted by the project is overcoming the difficulties blind people usually encounter whilst they are shopping autonomously, as if they could see, without the help of someone else. The focus of this work is to describe an inexpensive easily-deployable solution addressing this issue, entirely based on off-the-shelf technology (mainly smartphones). Unlike sighted individuals, many blind and VI people do not shop independently. They typically rely on friends, relatives, volunteers, and store employees. When these individuals are unavailable, VI shoppers have to reschedule or postpone shopping trips. When they go to the supermarkets by themselves, they experience delays, waiting for store employees to assist them. Some staffers are unfamiliar with the store layout, others become irritated with long searches and requests to read aloud product ingredients, and still others do not have adequate English skills to read the products’ ingredients or answer basic questions about the supermarket layout. These difficulties cause blind shoppers to abandon searching for desirable products, settle for distant substitutes, or, in the worst case, abandon independent shopping altogether. We would like to emphasize that training independent evaluators and having them evaluate various accessible shopping solutions in the field is beyond the scope and not feasible as well. Such an evaluation, besides requiring substantial budgetary commitments, does not seem feasible to us at the moment, because some systems exist only as research prototypes while others exist only on paper as patents.

The assumptions taken by the application regarding a supermarket organization are as follows. First, it is considered that all products are grouped into different product categories (e.g. drinks), and these are divided into product types (e.g. drinks/cola) which again are divided into concrete brand products (e.g. Pepsi can). Apart from that, the supermarket area is divided into cells of two main types: cells containing a shelf and passageway cells. The application offers infrastructural support for the whole purchasing process within a supermarket, which we understand as a four-step cyclic process: 1—product category navigation/2—product search/3—product identification/4—product selection. Such cycle stops when the user decides to go to the cash till to pay for her purchases. Consequently, the application offers a navigation component driving the user through voice messages to the aisle where a product category previously dictated to his smartphone is located. Once there, the application also offers support for product recognition by scanning the barcode of the product which is to be purchased and the identification of the scanned product is converted to a string of characters which is then converted to speech through which product identification becomes effortless and easy. The advantages of the proposed solution is that the capability of allowing blind people to easily select or browse through the available range of products, just before one initiates the purchasing process. Once the user is in the area where a product category is located, the blind person must be able to locate the concrete product types of his interest, and select the actual units he wants to purchase and that the blind person has prepared a shopping list (planned shopping) or rather prefers to go to different supermarket sections to browse and choose products (opportunistic shopping), the blind person must be offered support to navigate through the supermarket and reach to the

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wished section and as the Supermarkets are reluctant to introduce complex changes in their internal information management systems. Furthermore, only simple low-cost easily maintainable physical instrumentation of their premises including aisles and shelves is acceptable. User friendly and easy to use application which can scan all the barcodes and one can easily be converted to speech so that the visually impaired can easily shop.

II. OBJECT IDENTIFICATION FOR BLIND PEOPLE

Object identification is an essential and important task in our daily. Even though blind people are able to identify objects by tactual features but there are some differences between objects in optical appearance, for example, two objects with the same size and tactual features but with different labels. Although visual impaired people can ask for help from any sighted persons to differentiate between objects, this is can affect blind people independency. In addition, it is shown by previous study that the most common visual challenges for blind people is the need of help to identify an object. There are many assistive technologies that can be used to help blind people in identifying objects. These technologies can be classified into two classes (as shown in the first class is automatic services which include image processing, Barcode and RFID (Radio Frequency Identification Devices) while the second class is based on human-powered services.

III. SYSTEM ARCHITECTURE

Software design sits at the technical kernel of the software engineering process and is applied regardless of the development paradigm and area of application. Design is the first step in development phase for any engineered product or system. The designer’s goal is to produce a model or representation of an entity that will later be built. Beginning, once system requirement has been specified and analysed, system design is the first of the three technical activities design, code and test that is required to build and verify software. The importance can be stated with a single word “quality”. Design is the place where quality is fostered in software development. Design provides us with representations of the software that can assess for quality. Design is the only way that we can accurately translate a customer’s view into a finished software product or a system. Software design serves as a foundation for all the software engineering steps that follow Without a strong design we risk building an unstable system - one that will be difficult to test, one whose quality cannot be assessed until the last stage. During design, progressive refinement of data structure, program structure and procedural details are developed reviewed and documented. System design can be viewed from either technical or project management perspective. From the technical point of view, design is comprised of four activities - architectural design, data structure design, interface design and procedural design. In this paper we would describe the system architecture of the proposed system using the component and sequence diagrams respectively. A component diagram, also known as a UML component diagram, describes the organization and wiring of the physical components in a system. Component diagrams are often drawn to help model implementation details and double-check that every aspect of the system's required functions is covered by planned development. A component is a logical unit block of the system, a slightly higher abstraction than classes. It is represented as a rectangle with a smaller rectangle in the upper right corner with tabs or the word written above the name of the component to help distinguish it from a class. A sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function. These diagrams are widely used by businessmen and software developers to document and understand requirements for new and existing systems.

![Figure.1. Component diagram of the proposed system](http://ijesc.org/)
IV. SYSTEM IMPLEMENTATION

The proposed system which uses the barcode scanner to scan the product, hash map object to store the scanned barcode of the product and text to speech conversion for converting the name of the product to audio is described in detail which is as follows:

Barcode Scanner: Barcode is a simple data carrier which is most widely used in marketplace. It is printed on items in clear manner and used for many different reasons, but the most prevalent reason is to make the process of the termination the object easier. Barcode was used for assisting visually-impaired persons to obtain verbal information from product. The person can scan the barcode of the item by scanner unit, then listening to its information's through speech synthesis. Zxing is a popular Java based open-source library for QR/barcode decoding. The library has several functionalities but for the purpose of this work we would be using two packages namely core and android. The ‘Core’ component handles the image decoding functionality and the ‘Android’ component handles the Android client which is also known as QR Scanner. Fig. 4 describes the decoding algorithm developed in this work. At first the colored QR image is captured using mobile phone camera which is temporarily stored as bitmap image. The image is further subjected to various image processing methodology in order to split into three respective layers. The image processing algorithms improves luminance profile of the captured image. These separate layers are further thresholded to get the binary image which is read by the Zxing library.

Hash map object: HashMap is a Map based collection class that is used for storing Key & value pairs, it is denoted as HashMap <Key, Value> or HashMap<K, V>. This class makes no guarantees as to the order of the map. It is similar to the Hash table class except that it is unsynchronized and permits nulls(null values and null key). It is not an ordered collection which means it does not return the keys and values in the same order in which they have been inserted into the HashMap. It does not sort the stored keys and Values. We need to import java.util.HashMap or its super class in order to use the HashMap class and methods. The purpose of map is store value on the based on key that can be used to retrieve item at later point. HashMap is fail-fast iterator.( Iterator is an object that enables a programmer to traverse a container, particularly lists), HashMap cannot be shared between multiple threads without proper synchronization. Synchronization means only one thread can modify a hash table at any point of time.

Text to speech conversion: Text-to-speech synthesis (TTS) is the automatic conversion of a text into speech that resembles, as closely as possible, a native speaker of the language reading that text. Text-to-speech synthesizer (TTS) is the technology which lets computer speak to you. The TTS system gets the text as the input and then a computer algorithm which called TTS engine analyses the text, pre-processes the text and synthesizes the speech with some mathematical models. The TTS engine usually generates sound data in an audio format as the output. The text-to-speech (TTS) synthesis procedure consists of two main phases. The first is text analysis, where the input text is
transcribed into a phonetic or some other linguistic representation, and the second one is the generation of speech waveforms, where the output is produced from this phonetic and prosodic information. These two phases are usually called high and low-level synthesis. The input text might be for example data from a word processor, standard ASCII from e-mail, a mobile text-message, or scanned text from a newspaper. The character string is then pre-processed and analyzed into phonetic representation which is usually a string of phonemes with some additional information for correct intonation, duration, and stress. Speech sound is finally generated with the low-level synthesizer by the information from high-level one. Android provides Text To Speech class for this purpose. In order to use this class, you need to instantiate an object of this class and also specify the InitListener(). In this listener, you have to specify the properties for Text To Speech object, such as its language and pitch. Language can be set by calling SetLanguage() method. The method SetLanguage() takes a Locale object as parameter such as the various languages which are spoken. Once we have set the language, we can call speak() method of the class to speak the text. The proposed system would thus help the visually impaired to shop on their own with the help of the technology. The images below demonstrate the user interface of the proposed system which would convert the scanned barcode of the product to audio which in turn helps the visually impaired to shop independently.

![Barcode scanner opens automatically after the app is opened](image1.png)

**Figure.3.** Barcode scanner opens automatically after the app is opened

![Scanned result is obtained with a voice message](image2.png)

**Figure.4.** Scanned result is obtained with a voice message
V. CONCLUSION AND FUTURE ENHANCEMENTS

The project was created and aimed to support the visually impaired people and it is devised keeping in mind the difficulties the visually impaired people face in their day to day activities. The work has shown a low-cost easily deployable solution for blind people assisted shopping which consists of a mobile QR-code based product recognizer. It is important to note that although the chosen scenario was a supermarket, the platform can be easily adapted to any other self-service shopping scenario. A fully fledge evaluation in a real supermarket carried out by a statistically significant group of blind people will also be carried out to thoroughly assess the suitability of the proposed solution so as to make it a feasible solution for the efficient usage of the application. All the data related to the shops and supermarkets and it’s structure and the arrangements of various products in the shelves are stored beforehand using the cloud based data storage systems and the user can directly retrieve information effortlessly of the different shops and supermarkets that the user wishes to shop in and more features would be added to the existing application which would further make shopping for the blind effortless and easy. Further work will expand the Blind Shopping Android mobile application with GPS reading capabilities, so as to guide the user from her home to the supermarket.

VI. REFERENCES

