SelfLens: A Personal Assistive Technology to Support the Independence of People with Special Needs in Reading Information on Food Items

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Abstract. Grocery shopping or handling food items (e.g. packets, boxes, etc.) can be a very difficult task for people with special needs. Object labels may contain much information that can be difficult to read because the data shown is a lot, and the text is difficult to read by many people. Blind people are unable to get that information autonomously, and many sighted persons (e.g. elderly people and visually-impaired) may have a lot of difficulty in reading labels. Several tools or applications are available on the market or have been proposed in the literature to support this type of activity (e.g. barcode or QR code reading), but they are limited and may require specific skills by the user. Moreover, repeatedly using an application to read label contents or to get additional information on a product can require numerous actions on a touch-screen device. This can make their use inaccessible or unusable for many users, especially while shopping or cooking. In this work, a portable tool is proposed to support people in simply reading the contents of labels and getting additional information, while they are at home or at the shop. Our study aims to propose a portable assistive technology which can be used by everyone both at home and in the shopping, independently from the personal skills and without requiring no smartphone or complex device, and that is a low-cost solution for the user. Such a product could be very useful for the people independence in a period like that one we are living due to the lockdown required by the Covid-19 situation.

Keywords: Interactive Device, Accessibility, Shopping, Smart Home.

1 Introduction

People with special needs may face numerous difficulties in performing many everyday activities. Blind people, for instance, encounter many obstacles in carrying out tasks, such as shopping [14], managing products at home [8], and cooking [5] amongst others. Partially sighted people may also have problems reading labels or a large amount of content information printed on numerous products. This difficulty is due to the inadequate use of colors, inappropriate color contrast, the type and size of the text fonts, etc. [13]. Consequently, several issues are encountered when performing everyday activities, such as using products at home and at the shop.

In this context, some tools have been proposed to aid the visually-impaired to get information on products. At home, for instance, it is currently possible to use tools like the PenFriend labeler (www.rnib.org.uk/rnibconnect/technology/penfriend-3-audio-labeller), which can be bought on the market to allow people with visual impairments to label products (e.g. food items) themselves using their voice. For example, when placing a product in the pantry, a blind person has to record in braille or voice-based format the name, expiration date, as well as other additional information like important ingredients or key cooking instructions. This type of activity, however, is time-consuming and requires support from a sighted person to obtain the information from the product label. The tool ORCam (www.orcam.com) is also available on the market to read written text or identify products, but it is very expensive. On the other hand, some recent mobile applications like 'Seeing AI' proposed by Microsoft (www.microsoft.com/en-us/seeing-ai) can offer functions designed to read on the fly a written text or a barcode via a smartphone. Other studies have proposed alternative mobile-based technologies [10], however, they may require specific skills in order to use them. Elderly or disabled people might not like using touch-screen devices, because it can require technical skills or it can be very complicated [2]. Furthermore, using those applications while shopping or cooking can become a very arduous task for a blind person, especially to get information on elements like name and brand, expiration date, and so on. In addition, elderly or partially-sighted people will likely need to use glasses or a magnifying lens to be able to read that information. For these reasons, we propose a standalone tool, which does not require a smartphone and is very simple to use for both sighted and blind users.

In this work, we present a potential portable tool named SelfLens designed to support anyone in using autonomously products and items both at home and in the shop, especially in getting specific information on the product itself. The tool we propose is aimed at (1) making people with special needs autonomous in reading information on a product, (2) offering a device which is easy to use by anyone at any time without requiring advanced skills, and (3) proposing a portable and low- cost solution.

The proposed solution might be particularly useful in a context like the one caused by issues due to Covid-19. Lockdown does not allow the visually-impaired and elderly people to receive adequate assistance from other sighted people. Autonomy is particularly useful, especially to check the name and expiration date of home-delivered food items purchased online.

2 Related work

Numerous studies have been investigating possible tools and services designed to support visually-impaired people with shopping [4], [7] and [15]. However, the technologies proposed are mainly intended to assist navigation, and others to locate the products in the shop [3], [9], [11].

Our study is particularly focused on the accessibility of the information written on product labels, in order to allow people with special needs to be able to read them autonomously. This can be very useful both at home [8], [14], and at the shop [15]. Unfortunately, this feature risks being undervalued when considering the main needs and numerous actions to carry out in autonomy at home and when shopping [6]. The main issue is related to the difficulties in reading textual contents written on the labels. This is a problem encountered not only by the visually-impaired, but also by the sighted. In fact, the study reported in [13] suggests personalizing eBook visualization to adapt the rendering for sighted, visually-impaired and blind people. These results reveal the need for text customization functionalities in reading tools, as well as the opportunity to provide the information in an alternative way in specific contexts, such as shopping.

Our solution is based on a QR code approach, with some changes. Results reported by the study [1] indicate that a QR code solution can be used for visually-impaired users when shopping. However, in this case a smartphone is needed in order to use this application, as is also the case for the solution proposed in [12]. In fact, several proposed tools to support blind people in recognizing products at the shop are based on touch-screen devices, such as [10]. This requires certain digital skills by the user. On the contrary, our solution is aimed at offering a tool which can be used also by those people who are not familiar with smartphones. In addition, using an app on a smartphone may require numerous steps (e.g. taking the smartphone, unlocking the screen, finding the app, interacting with the user interface, etc.) to be performed when getting information about a product. This is not so practical when performed frequently and on a daily basis, such as when shopping. Our approach is to gain access to the information quickly by pointing the device at a product and just pressing a button This should be easier also for those who are less experienced with technology.

3 The Proposed Tool

In this section, the proposed tool is introduced by providing a description, the main features, as well as the necessary architecture.

3.1 Description

A portable tool named SelfLens has been proposed as a personal assistive technology which can be used by everyone, including elderly, partially-sighted, blind and hearing-impaired people to get information on a product, which is usually available on its label. The device is able to provide information on the (a) name and brand, (b) components such as ingredients, allergens, etc., (c) prices and discounts, and (d) instructions or other information about the product usage.

The device looks like a remote control that can be easily held in one hand. The tool is designed to be used by any person, by simply (1) pointing at the product and (2) pressing a button to get information on it or to buy it. The information is provided on demand and presented both via voice messages and on a small screen. In Fig. 1 how the tool can be used by a user to get information on a product is shown. The tool is also designed to be used for purchasing the desired products, but this function will be better designed in the next version of the prototype.

To sum up, the tool SelfLens has been built to provide:

1. Product recognition: thanks to a special coding system used to mark each product, Self-Lens is able to recognize it by using a video camera;
2. Product information: for each product, Self-Lens is able to provide information on the name, prices, expiration date, components and ingredients, etc.
3. Product purchasing: the user will be able to buy the product immediately, or add it to the shopping cart to place the order at a later time.

Fig. 1. A customer collecting information about a product using the SelfLens device.

3.2 Prototype Features

The tool has been designed so that it can become a practical assistive tool that can be on hand and used by everyone at any time without the need for specific skills or mobile smartphones. The user can use it to get the product information very quickly and (if required) buy it in just one click. It could be useful both in the home and in the shop. Therefore, its usage should be very practical and immediate.

The tool has been designed so that it has the following features:

- Simple and practical interaction: thanks to a minimal User Interface (UI) composed of only two buttons, one display, and a speaker, The tool can be easily and practically used by everyone;
- Portable and lightweight: the tool looks like a small remote control which can be held in one hand;
- Multi-purpose functions: the tool is able to provide (1) text information and (2) purchasing functions;
- Audio and visual feedback: in order to ensure full inclusion for people with different types of disability, information as well as the dialogue messages are provided to the user via both audio and visual perception.

3.3 Tool architecture

SelfLens is a tool based on a system which is composed of three main components: (1) the portable device, (2) the marker code for each product identification, and (3) a products database. The connection between the device and the database is based on a SIM card. The user relies on the portable device as the main component of the system. More specifically:

Portable device: it is used by the user to identify each product through a video camera, and to get information via vocal messages (through the speaker or ear-phones), or written messages (through a display). A SIM card is installed to connect the device with the database on the net.

Marker code: it is used to mark each product. It is based on a QR code solution, with some differences in the shape and size of the printed code. This is because the needed information for each product requires a lot of space, which cannot be guaranteed by an everyday QR code.

Products database: it is used to store and retrieve information on each product. The content of the product labels is structured and stored in this database, which is located on the net. The link between the product and its data is based on the marker code ID. Since some issues on the connection between the device and the database can occur, a local instance of the database is stored in the device memory. In this case updated and context-dependent data like the prices and offers (which are shopping store-dependent) could not be provided to the user. The device regularly updates the local database with the content of the database on the network.

4 Design requirements

When designing the prototype (see Fig. 2), some specifics and functions have been defined sections. The specifics regarded the following aspects:

- Recognition via a properly-designed code to mark any product and also to overcome some limitations of existing QR codes or barcodes; Shape and size were designed to adapt the marker code to the item and its contents. The code is a label which can be attached onto the product. A blind user can identify it by touch and its position, which is the same for each similar product (e.g. on the stopper or on the corner of boxes and packets). In addition, the tool supports the identification of the code through audio feedback.
- Functions are triggered by the two buttons according to the type and number of presses.
- Feedback messages are defined according to the current function and the output modality (voice or screen).

4.1 User interface and components

The tool has been designed as a device with a rectangular shape, a display on the front, two buttons (circular and square), and a video camera located on the back (see Fig. 2). The speaker on the front, located below the two buttons, has been added to provide information via voice messages and short sounds. The two buttons have been designed with a different shape and label ('I' for information, and 'A' for purchasing) to make them easily distinguishable by touch.

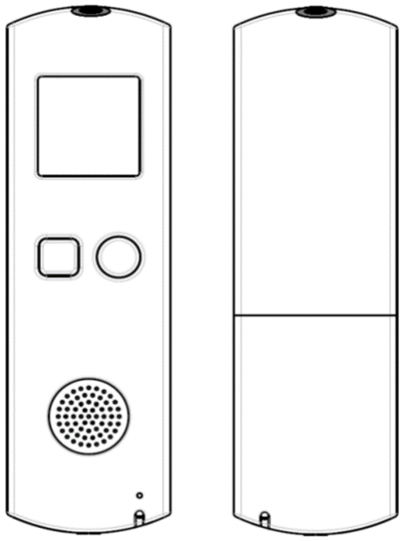

Fig. 2. Prototype with the camera on the top.

4.2 Functions triggered by the buttons

The device is designed to receive 9 commands triggered through the two buttons (circular and square), which can be pressed separately or simultaneously. For each function, the button pressure, function name and description as well as both audio and visual feedback are explained. With reference to each button, the type of pressure on the button (how many times and seconds) is reported as a command to use to trigger the related function. The circle button ('I') and square button ('A') can be pressed separately or simultaneously.

Table 1 reports an example of how three functions have been assigned to a single (circle) button. A similar approach can be used for the square button.

Table 1. Functions assigned to the circle button (labelled with 'I').

Action	Function	Description
1 press 1 second	**Product info**	Name, expiry date
2 presses 1 second	**Product details**	Name, exp. date, price, allergens, ingredients
1 press 3 seconds	**Switch on**	The device is turned On. It is turned Off after 5 minutes of inactivity

5 Pilot evaluation

A first version of the prototype was analyzed with the support of 3 sighted users and 3 blind users. The aim was to use the feedback to design and refine (1) the interaction mode and (2) the functions assigned to the two buttons of the device. Other user interface components have been considered in the life-cycle of the product. Specifically, various aspects were evaluated with the end-users, such as (a) the position of the video camera installed on the device to detect the product from the special marker code, (b) the number, shape and size of the buttons, and (c) the main functions to consider in the first prototype. The first prototype had two buttons with the same shape and size. The evaluation with the users revealed that two very similar buttons can be confusing for the user, resulting in a poor natural interaction while using the tool. In addition, based on the fact that the second button will be dedicated to purchasing, the users commented that the purchasing operations need to be done safely, without the risk of mistakenly pressing the button which immediately starts the purchase. They observed that “one-click” certainly may facilitate the purchasing tasks, but the device should be able to avoid unintentional purchases. Another aspect considered in the evaluation was the camera position. The first prototype had the video camera on the top; regarding this, the users commented that pointing the product with a camera located at the bottom, as if the device were a smartphone, might be more practical since the user interacts in this way for other activities. This aspect will be considered in a second version of the prototype.

6 Conclusions

In this work, a portable personal device has been presented as a potential assistive technology to get information on items and products. The SelfLens tool has been proposed to be (1) easy to use for everyone, (2) portable and practical, (3) suitable for various types of needs thanks to the audio and visual feedback. The tool is able to provide information on (a) names and brands, (b) prices, (c) ingredients and components, and (d) additional information such as instructions and so on. The proposed tool differs from the existing solutions due to the fact that no digital skills are required to use it, and it can be used by everyone, not just a single category of users. SelfLens can thus offer the elderly and people with disabilities the opportunity to become more autonomous both at home and at the shop in just one click. SelfLens could be a personal assistive technology useful to support the autonomy of people with special needs in the critical situation caused by the Covid-19 lockdown, thanks to the opportunity to check product information or send a purchase order to the favourite store. Future work includes user testing conducted with end-users to evaluate the proposed functionalities and building a new version of the prototype to develop the purchasing function assigned to the square button.

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