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VisionCart : Self-Reliant Shopping Experience for Visually Impaired Individuals

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Abstract: **-** Shopping has been a long-presented significant challenge for the Visually impaired individuals. "VisionCart" is a mobile application implemented to address the core needs of visually impaired individuals. This application is a combination of a QR product identifier, a Wishlist manager, currency recognition, a volunteer connector, and an offer manager. VisionCart empowers visually impaired individuals with a newfound sense of self-reliance and independence during their shopping journeys. The current system stands as a promising technological solution to the daily challenges faced by visually impaired individuals in the realm of shopping, promoting inclusivity and independence.

Keywords*:* ***mobile application, visually impaired, currency detector***

1. Introduction

Visually impaired individuals do lead a normal life with their own style of doing things. However, they encounter more difficulties during the day-to-day work than a sighted individual. Shopping has always been a significant difficulty among the other difficulties for them because, from selecting the right products to making the payment to the cashier, they have to rely on someone's assistance.

In shops, visually impaired individuals face several challenges when relying on shop employees for assistance. These challenges encompass unfriendly shop assistants who get irritated for long product searches, embarrassment to request some products, social anxiety, breakdowns in communication, and the added complexity of handling cash at the cashier without assistance. These difficulties collectively underscore the growing necessity for self-reliant shopping.

Self-reliant shopping is something that visually impaired people have never experienced. Self-reliant shopping increases the independence, flexibility, and convenience of visually impaired individuals. Therefore, the need to find a solution to this situation by using novel technologies has been emphasized.

With the advancement of new technologies mobile phones have become indispensable devices for people. Current mobile phones offer a variety of accessible features tailored to visually impaired individuals. With the aid of "TalkBack" and "VoiceOver" visually impaired individuals can also use mobile phones [1] [2]. Considering all of these, VisionCart is designed as a mobile application, that will act as a solution to above mentioned problem. The proposed application's primary objective is to enhance the shopping experience of visually impaired individuals.

The challenges faced by individuals with visual impairments during shopping can be categorized into three main categories: selecting the correct product, obtaining assistance from the right individuals, and accurately completing payment transactions. Those three reasons have been taken as primary requirements of Visioncart. This application not only addresses these core needs but also incorporates valuable input from visually challenged users through specific voice-enabled features. Furthermore, the proposed application provides an excellent opportunity for individuals interested in contributing to society. It allows willing volunteers to offer assistance to visually impaired shoppers, aligning with the ethos of social responsibility. In summary, VisionCart encompasses

four key components: product identification, shopping cart management, volunteer services, and currency identification. Additionally, an added feature of offer management informs visually impaired users about available discounts and promotions.

2. Literature Review

Giving an effective solution for the challenges faced by visually impaired individuals while shopping has been the core objective for many prior projects. However, they were not able to address all the issues. Some of those projects require external hardware devices which adds an extra burden to visually impaired individual's life. Moreover, these people cannot afford some of those projects due to their high cost.

As depicted in Table 1, existing projects can be categorized into the following categories based on their core objective.

TABLE I. EXISTING APPLICATIONS

Core Objective	Existing applications
Improve the shopping experience of blind individuals.	ishop, Trintera, iCare, ShopTalk, RoboCart [3] [4] [5] [6] [7]
Assist blind individuals in identifying products while shopping.	InteligentEye, Drishti [8] [9]
Assisting blind individuals to identify currency.	Forey [10]
Connect blind person with a volunteer to get assistance.	BeMyEyes [11]

- iShop: A mobile application developed by the Sri Lanka Institute of Information Technology to make shopping easy for visually impaired individuals. Helping to navigate around the shop to find products acts as the most critical feature of this application [3].
- Trinertra: A cell phone application developed by CyLab, Carnegie Mellon University. It uses external hardware devices like BaracodaPencil or IDBlue pen [4].
- iCare: A text reader developed by the Arizona State University, USA. This is a hardware device that facilitates visually challenged individuals to read printed texts [5].
- ShopTalk: A software that is designed to give an independent shopping experience for visually challenged people; designed by Computer Science Assistive Technology Laboratory, Utah State University Logan [6].
- RoboCart: A robot developed by Utah State University, USA to assist visually challenged individuals to navigate around the shop [7].
- InteligentEye: A mobile application developed by the Arab Open University, Lebanon. It contains features such as colour detection, light detection, object recognition, and banknote recognition [8].

- Drishti: A mobile application developed by the Sanghvil College of Engineering, India. This application facilitates blind individuals to navigate without using any hardware devices [9].
- Forey: An android application developed by the Pillai College of Engineering, New Panvel. This application helps visually impaired individuals to identify cash by using machine learning [10].
- BeMyEyes: An android application developed by Jawaharlal Nehru Engineering College, Aurangabad. This application connects visually challenged people with a volunteer to get instant help [11].

TABLE II. COMPARISON OF DEVELOPED APPLICATIONS WITH THE PROPOSED APPLICATION

Features	iShop	Trinetra	iCare	ShopTalk	RoboCart	IntelligentEye	Drishti	Forey	BeMyEyes	VisionCart
Product scanning and getting details	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
Manage shopping list	Yes	No	No	No	No	No	No	No	No	Yes
Offer alerts	Yes	No	No	No	No	No	No	No	No	Yes
Currency identification using scanning.	No	No	No	No	No	No	No	Yes	No	Yes
Connecting to a volunteer.	No	No	No	No	No	No	No	No	Yes	Yes

The development of screen reading software, such as TapTapSee, Talback, and VoiceOver has significantly enhanced research efforts focused on individuals with visual impairments [12] [1] [13]. The development of this software led to the popularity of modern touchscreen smartphones among visually impaired individuals.

3. The System and Its Features

The proposed application contains the following 5 main features:

A. Product identification and Shopping cart management

This module of the application allows the user to scan the QR code and identify products using their mobile phone camera. When the user scans products, the app gives product details to the user by voice message, and also user can also add that item to the shopping list by voice commands. Items can be deleted from the card when the user requires them.

B. Wish list management

This module allows the users to create a Wish list. Item adding can be done by voice commands. Users can delete items based on their requirements. This module is specifically designed to avoid getting missed items while shopping.

C. Volunteer services

This module allows visually impaired individuals to request a volunteer to get assistance. Every volunteer registered in this system gets a notification when a visually challenged person requests for assistance. Visual-impaired individuals can give a rate for the service they received from the volunteer. Based on the rating volunteers receive points. Total points can be used to get discounts from the shop.

D. Currency identification

This module allows users to recognize Sri Lankan currency notes according to their denomination. The currency detection system is based on the image processing technique.

E. Offer management

This module gives offer details. shop owner can add offer/Promotion details to the system. Once they add an offer, a notification is sent to every visually challenged person who has registered through the system. Visually challenged individuals can customize the notifications based on their preferences.

4. Methodology

A. QR scanning

QR detection is done by the user's phone's camera (in "Fig. 2"). After successful detection of the QR code, the system retrieves data from the database based on the encoded unique ID in the QR code (b in "Fig. 2"). Then the retrieved data is converted to voice using Text to Speech API (c in "Fig. 2"). After giving a voice output (d in "Fig. 2") the system asks users whether they want to add that item to the shopping cart.

B. Currency Detection

As the initial step of currency detection, users have to scan the currency using their phone's camera. Then the currency is recognized by the CNN Model. Finally, the output is given as voice using the Android Text to Speech module [12].

The most important aspects of the currency detection system are the Tenser Flow Lite model and the Teachable machine. These tools act as the classification model for the project. Convolutional Neural Network (CNN) is also used as a classification algorithm in the classification process. A CNN model is chosen for its effectiveness in image classification tasks. The model is trained on the preprocessed dataset using transfer learning, exploiting a pre-trained model's learned features to enhance recognition accuracy.

C. Shopping Cart

Users can view and delete items in the shopping cart based on their preferences. Additionally, items get deleted automatically after 2 months.

D. Voice Navigation

Once the user clicks the button (4 in "Fig. 1"), the user's mobile phone's microphone captures the user's spoken command (a in "Fig. 4"). At the end of the command system determine whether the user has finished speaking (b in "Fig. 4"). Then the captured audio is converted into numerical features that capture speech patterns (c in "Fig. 4"). Advanced algorithms analyze these features to recognize the spoken words (d in "Fig. 4"). Then the system identifies the user's intent or command from the recognized words (e in "Fig. 4"). Finally, the system takes appropriate actions based on the user's intent, such as navigating among pages and giving text input (f in "Fig. 4').

E. Volunteer Connecting

Users have to fill out a form to get assistance from a volunteer. Inputs to the form are taken as voice inputs and then converted to text using speech-to-text API. Once the request is sent, every volunteer gets the notification. After the acceptance of the request, a confirmation message is sent to the user's phone. Additionally, users can listen to their assistance history from this feature.

F. Wishlist management

Users have to double-tap the screen to add an item to the Wishlist (a in "Fig. 5"). Then the system asks for the product name and quantity separately. The system takes inputs as a speech (b in "Fig. 5"). Then the system stores the user's inputs as texts in the database using Speech to Text API (c in "Fig. 5").

Users can listen to the list of items in the Wishlist when they click a button. When the button is clicked, system (c in "Fig. 6") retrieves the data from the database (a in 'Fig. 6") and gives a voice output using text to Speech API (b in "Fig. 6").

Wishlist items get deleted automatically after 2 months and the user can clear the Wishlist by pressing a button.

G. Offer Details

Users can here on the available offers. Shop owner can add, update, and delete the offer details based on their preference.

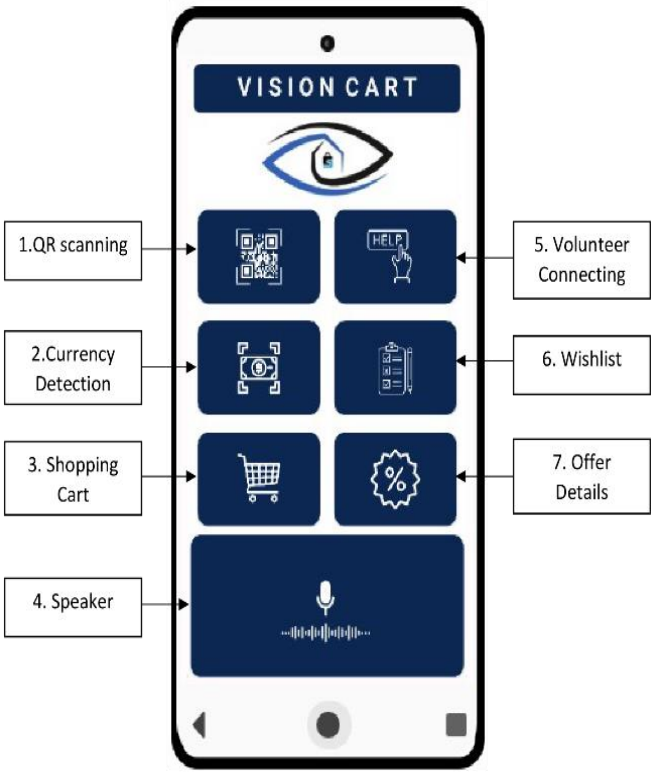

Fig. 1. VisionCart's Dashboard

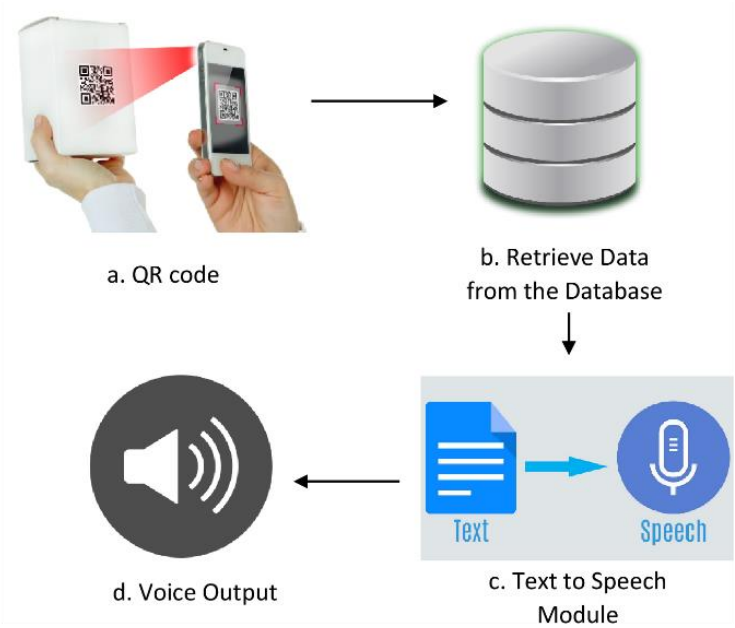

Fig. 2. QR detection Process

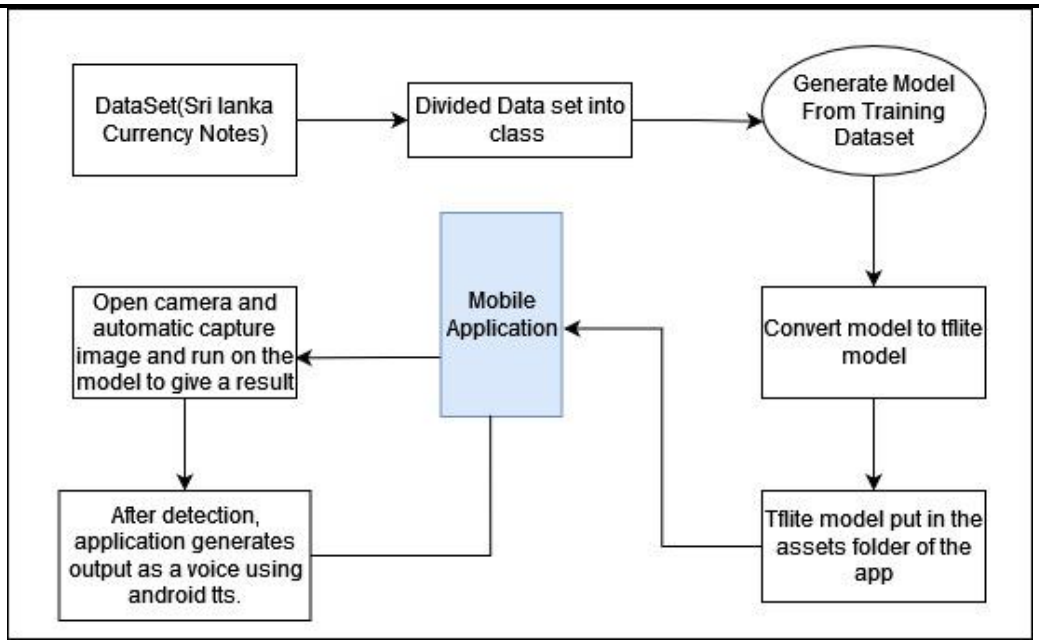

Fig. 3. Currency Detection Process

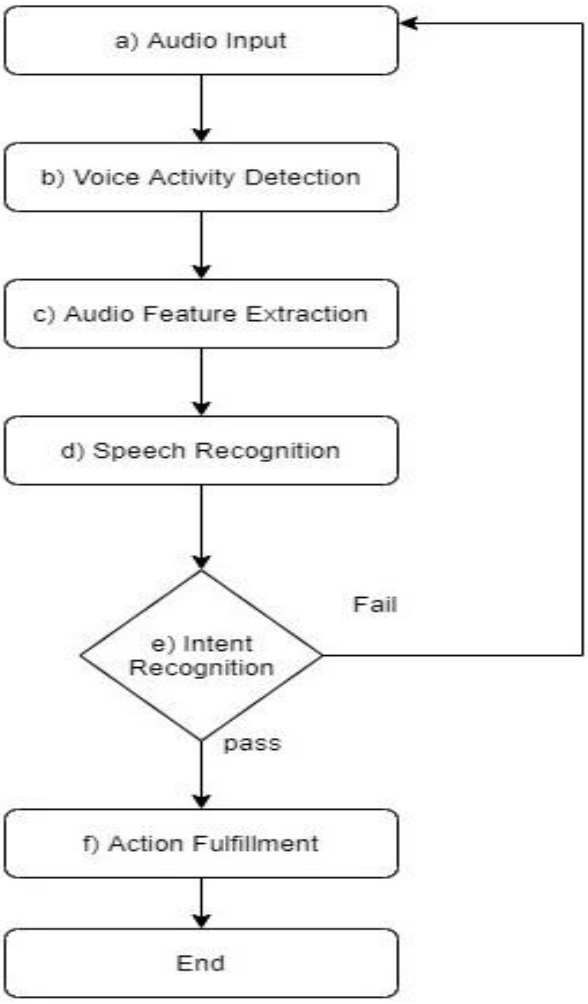

Fig. 4. Voice Navigation Process

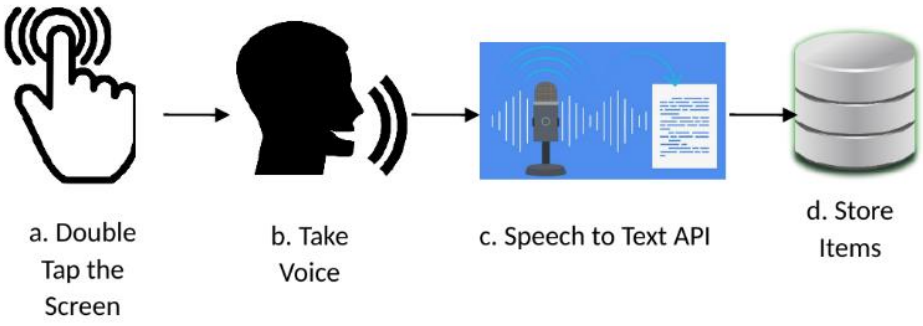

Fig. 5. Adding items to wishlist

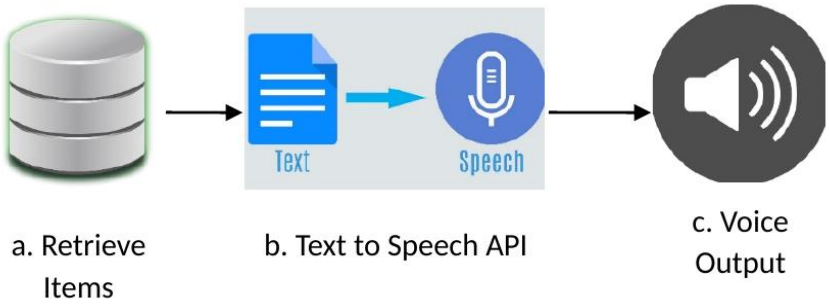

Fig. 6. Reading items in the Wishlist

5. Results and Discussion

A. Success

The current currency identification system is incapable of producing output of the same quality as a sited person. Because the lighting of the background, folds, and tears of the cash cause the system to generate the wrong output for the users. However, achieved nearly 85% currency-detecting module accuracy by uploading 500 photos and establishing correct epoch values.

Speech recognition accuracy depends on factors like background noise and the quality of the microphone. Sometimes the system leads to incorrect representation due to ambiguous or misunderstood voice commands. Voice detection was tested 100 times, and the success rate was 90%.

B. Future Research Directions

This application's currency recognition system can only be used for Sri Lankan notes. This feature can expand to detect coins and fake currencies.

The volunteer connecting feature can be improved by allowing volunteers to video call assistance needed for visually impaired individuals to improve the assistance effectiveness.

This application is developed for Android users. This can be developed for iOS users since it is the second-largest operating system with a 28.52% global market share [13].

6. Conclusion

VisionCart helped to overcome the difficulties of visually impaired individuals during shopping by providing a valuable set of features. Product identification using QR codes, currency identification, and voice navigation

features helped the user gain a self-reliant shopping experience. Furthermore, the Wishlist management feature allows users to manage their shopping.

To provide this valuable output, VisionCart, technologies like machine learning, Text to Speech API, Speech to Text API, CNN models, and tflite model had to be effectively used. However, this application can be developed further by improving the effectiveness of voice recognition and currency identification. Adding new features like a video calling option for volunteers will cause a significant change in user satisfaction.

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