Smart Bus Tracking For Blind And Visually Impaired

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Abstract. Visually impaired and blind people (VIBP) face great difficulty finding public transport and bus stops due to their visual impairments. Over the past decade, several support systems have been prototyped and developed to address this problem. However, most of these are wearable prototypes that turn out to be grueling for them. In this project, we propose an AI-powered real-time bus navigation system that provides information about buses arriving at bus stops. The buses will be tracked using the GPS of the mobile phone installed with the driver-side application. The application will take audio input for the source and destination for the journey and provide the available buses from the nearest location of the user on that route as audio output. It will provide the ETA and location of the target bus. This app will coordinate with the driver's app and live notifications will be given to the driver for any visually impaired passenger.
Keywords– VIBP, AI voice assistant, real-time bus tracking, GPS, Google Maps.

1 Introduction

According to a WHO survey [1], it is estimated that there are 285 million people with visual impairments. 39 million of them have a visual impairment and 246 million have low vision. There are many challenges for people with visual impairments, especially when it comes to using public transportation[2]. In any unknown environment, navigation and orientation are traditional challenges. Buses are widely used for transportation in major cities. Most blind and visually impaired individuals depend on public transportation for their transportation needs, especially trains and buses, because public transportation is the only viable option for seeking education, work, and social networking [3][4].

In the limited environment they live in, they aren't able to perceive the outside world as well as others, and this is having a negative impact on their activities, such as in education or transportation since they rely on only their own intuition. Among other resources, it gives them access to employment, community resources, health care, and recreational activities [5]. Despite established public transportation infrastructure, it is not easy or comfortable for the visually impaired to use it. They are forced to settle for less-productive local employment opportunities due to unfriendly public transport systems not tailored to their needs. The majority of the visually impaired choose not to go to work far from home. This often makes them settle for less than what they could actually do.

Volunteer organizations such as helping hands provide important assistance to the visually impaired community[6]. They provide mobility training and other forms of assistance. It's very important for a visually impaired person moving into a new area to be able to get around with the help of a trained and knowledgeable guide. However, these solutions make the visually impaired dependent on travel aids, which makes it impossible to navigate outdoors without the assistance of a professional.

This paper presents a systematic and structured way to provide bus arrival information at an individual bus stop via a mobile application, which takes into account the voice of the visually impaired person when receiving the bus destination. The voice assistant will constantly

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assist and update the visually impaired person till they reach their destined bus station. The estimated arrival time of the desired bus at the bus station will be updated and informed in real-time. Once the person has boarded the bus he/she will be assisted and notified when they are about to reach their desired bus station so that they can stay alert and get down from the bus without any confusion.

2 Literature Survey

"An RFID Based System For Bus Location Tracking And Display" [7]. This paper uses an RFID system and RFID tags are embedded on buses and readers at alternative bus stops, to detect buses. The local government server receives information and displays all of this data at the bus stop. This system is not very economical to implement on a large scale since the RFID tags are expensive.

"Smart Bus Alert System for Easy Navigation of Blind" [8] proposes to provide a solution using a wireless sensor network (WSN). The ZigBee system is used to indicate that there are blind people at the bus stop. The voice module and APR9600 voice playback system are used. Since ZigBee has a range of 300-400 meters, this system can be an advantage[9]. In this system visually impaired people must carry a ZigBee mobile unit, this unit has a certain size and weight that make it difficult and troublesome to carry for them [10].

"Implementation of a Navigation Application for the Visually Challenged" [11]. Visually impaired people face many challenges while navigating both indoors and outdoors. Indoor navigation is provided with the help of Bluetooth Beacons and Indoor Atlas technology. This application provides voice assistance to users to navigate to their destination.

"Wireless Bus Identification System for Visually Impaired Person" [12],uses RF-based wireless communication to simplify movement for the visually impaired. The system consists of an RF module and ultrasonic sensors. The blind person activates the toggle switch which sends a signal to the bus driver who then helps them board the bus.

"Easy Navigation of Bus using Alert system"[13]. The bus alert system contains a microcontroller for processing bus route data and an RFID reader for reading bus routes and numbers at bus stops, as well as an LCD window to display the bus arrival status. The aim of this paper is to provide information on bus time and bus statuses. "Navigation of Blind People Using Passenger Bus Alert System"[14], ARM-7 is used to generate signals that are sent to to bus to indicate the presence of a blind passenger.

"BlindNavi: A navigation app for the visually impaired smartphone user[15]. Breadcrumb files are used. Based on the information on the breadcrumb that is given by the sensors, we can gain the desired location on the same. Despite its cost-effectiveness, the model lacks accuracy. "A radio network for guidance and public transport assistance of the visually impaired"[16], introduced a portable handheld device called "PAVIP transport system." It utilizes a PAVIP box in conjunction with the radio module installed on the device, which allows information to be exchanged between the vehicle and device. Using RFID chips, it sends route numbers, directions, and the next stop, but the disadvantages are that the signal may overlap with other signals.

"TYFLOSET" was proposed by Chechak J.[17], which combines a guiding system and a voice playback system. Using this system, the user is able to request driver information and the bus schedule while operating the acoustic system. The RAMPE model developed by Baudoin, G. et al. [18] is intended to provide an interactive mode of transport to the blind. But the vehicle does not interact directly with the user [19]. Using the Intermodal Transport Control System, Bischof et al. proposed the model, "NA VCOM," which utilizes the air interface. This model has the disadvantage of no direct communication between the user and the bus controller. It was hard to establish a new connection and sometimes hard to locate a new WLAN connection[20].

3 Problem Statement

For most visually impaired people today, public transport is the most convenient means of transportation. However, the existing infrastructure of bus transportation is inadequate for people who are visually impaired. There is no word on whether the bus they need is available. Considering the discomfort of traveling by bus, most of them avoid going to work at distant locations from their homes. It is therefore imperative that a system be developed for the purpose of easing the commute process of visually impaired people by bus. It should allow them to easily locate the bus that takes them to their destination. In order to make bus travel convenient, they should be informed when the bus is approaching and time of arrival.

4 System Design and Specifications

A system that is user-friendly and cost-effective is proposed to help visually impaired people navigate buses. This system consists of two major units- User Unit and Driver Unit.

1) User Unit This is the core of the system and the most important module. In order to activate this module's voice assistant, users need to tap the screen. All the bus details can be accessed from their smartphones. It is possible to track the location of a bus from any location. Users must ensure that their location services are active. Once the voice assistant is activated, the user can either ask for the nearest bus stop from their location or can ask for the bus number going to their desired destination bus stop.

2) Driver Unit This module can be used by authorized bus drivers. Before driving, they must activate their location services. Using a GPS device on the driver's mobile device, the server is automatically updated with the current latitude and longitude of the bus. The driver can start a new bus session or can select the bus from the list of already active buses. If the driver starts a new bus he can select the start and end of the bus from the given list. Whenever a visually impaired person gives a request for a particular bus the system sends a notification to all the active buses whose stops match with the given source(S1) and destination (D1) by the visually impaired user to indicate the presence of a visually impaired person along with their source and destination to the bus driver.

5 Methodology

Figure 1 shows the functioning of user unit and Figure 2 shows the functioning of driver unit. When the visually impaired person opens the application Google Maps API and GPS (Global Positioning System) fetches the real-time coordinates of the visually impaired person. Then by tapping on the screen the visually impaired person activates the AI voice assistant. The voice stream given by the user is converted to text via speech to text feature and is sent to the DialogFlow. DialogFlow agent handles the types of conversations and translates user audio input during a conversation to structured data. The user can either ask for the nearest bus stop from their location or for the bus number going to their desired destination bus stop. The nearest bus stop is calculated by finding the minimum distance between the location of the user and the bus stop. All the distances are calculated by using the open route service api and the Flutter Geolocator Plugin. If the visually impaired person doesn't explicitly give the starting point (S1) of their journey the system considers the nearest bus stop from the user's location as the beginning of the journey. Once the user has given a source and destination, the system looks for the matching destination in the list of bus stops of the upcoming active buses in the firebase cloud.

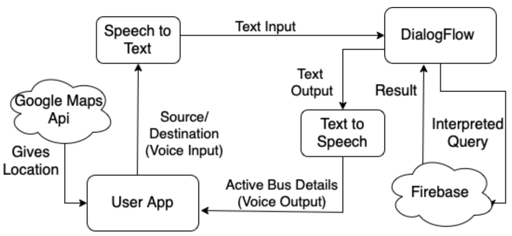

Figure 1: Functional Block Diagram of User Unit

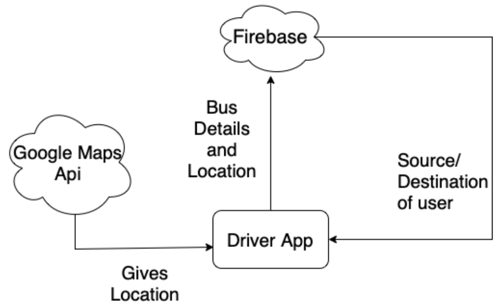

Figure 2: Functional Block Diagram of Driver Unit

If the destination matches, the system will announce the upcoming desired bus if the bus is within the range of 500m and 50m. If no information is given, it again asks for source and destination. When the target bus crosses S1 the AI assistant asks the user if they were able to embark the bus? If the user says no, then the next nearest upcoming bus for D1 is announced to the user. If the user says yes, then the application starts checking if the destination of the user has arrived. When the location of the bus matches with the location of destination, the AI assistant announces that the destination has arrived. The user can also access the location of the bus anytime during the wait and the journey by long pressing on the screen. On the driver side application of the system, the driver has to select the bus they will be driving and the start and end of the journey of that bus from the given list. The location of the bus is stored in the Firebase which will be updated continuously. Whenever a blind person gives a request for a particular bus the system sends a notification to all the active buses whose stops match with the given source(S1) and destination (D1) by the blind user. This way the system is able to indicate the presence of a blind person along with their source and destination to the bus driver so that they can wait longer than usual for the blind person to embark and disembark the bus. When the blind person is in the bus and their destination is about to arrive the notification that was given initially to all the active buses going to D1 are removed.

6 Result

An experiment was conducted to check if the interface was easy to use. A total of 85 students were blindfolded and were asked to interact with the application and were asked to rate their level of satisfaction on the scale of 1-10, 1 being the lowest and 10 being the highest. Figure 3 displays the overall results obtained.

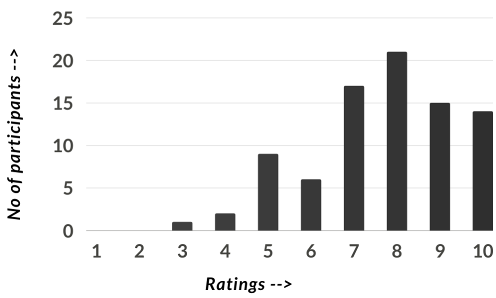

Figure 3: Statistics of survey responses

Based on the analysis of Figure 3, 86% of the participants have given a positive response, 11% gave a neutral response and 3% gave a negative response.

To test the functional efficiency of the proposed system, the prototype has been installed in the user's mobile and the driver's mobile with provided internet, in order to try all the possible solutions. A vehicle roamed through the roads of DY Patil campus in Nerul city for several days and at different times, for testing the functionality of the application. In accordance with the system model, this information is transferred via the internet to a Firebase server and then to the Android mobile application. Table 1 represents the interaction between users and the application on the end-users mobile application.

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Table 1: Table of solutions and outcomes

Requirements Identified	**Solution Build**	**Outcome**
Finding nearest bus stop	U1: "Where is the nearest Bus stop?" A1: Nearest Bus Stop is *Name of the nearest bus stop*" U2: "Okay" A2: "You want to go from *Name of the nearest bus stop* to?"	Information about the nearest bus station is made available easily.
Finding bus	Case 1: The source bus stop is the nearest bus stop U1: " Take me from Datta Mandir(source) to Bahnani Chowk(destination)" A1: "Do you want to go from Mandir(source) to Bahnani Chowk(destination)" U2: "Yes" Case 2: The source bus stop is not the nearest bus stop U1: " Take me from Nerul Sector 21(source) to Bahnani Chowk(destination)" A1: "Do you want to go from Mandir(source) to Bahnani Chowk(destination)" U2: "Yes"	Helping to find the desired bus without assistance from any volunteer or any abled person.
Approaching bus	A1: Bus number N2 is within 500m of your bus stop A2:Bus number N2 is within 50m of your bus stop.	Alerts are given for the desired bus.
The bus has arrived at Source bus station	A1: Bus number N2 has arrived at your bus stop please board the bus	Alert is given so that the visually impaired person can board the bus.
The bus has left the user's starting bus stop	A1:Have you embarked the bus? U1:Yes A2:Distance from the destination is 1500m.	To make sure that the visually impaired person has boarded the bus, if not then details of the next nearest bus qualifying the user's input are made available to the user.
The Bus is about to approach to destination	Instance 1: The bus is 50m away from destination A1: You are about to reach your destination, prepare to disembark Instance 2: Bus is 25m away from destination A1: You are about to reach your destination, prepare to disembark	Alert the visually impaired about their approaching destination.
The bus has reached the destination of the user	A1: You have reached your destination, please disembark A2: Did you disembark? U1: Yes	Provide assistance to disembark the bus.

7 Conclusion

Using this proposed scheme, visually impaired individuals can independently travel by bus from their current location to their desired destination without encountering any obstacles. It is possible for users to get information on the nearest bus stops and when their desired bus will arrive through this application. This allows users to plan routes and itineraries accordingly. The advantages of this application are: (1)Easy to use (2) Users can travel independently. (3) Users don't need to carry another device for navigation.

8 Future Scope

The proposed system achieves the framework objectives, but there are still some improvements that can be made to make the system better. This system can be further enhanced to provide communication between the visually impaired person and their relatives and in case of any emergency, send the user's current location and destination to them. The system currently depends on the application to be installed by the driver on their smartphone. In the future, the software in the buses can be modified to include the current functions of the driver-side application. This will eliminate the need for the driver to explicitly carry a smartphone. The application interface presently focuses on the needs of visually impaired people. This system can be further extended for the use of all individuals.

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