A Case Study on Integration of Google Map features to develop a Voice-Based Navigation System for Visually Impaired in a University

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Abstract*:* This paper proposes a voice-based step-by-step indoor navigation system for the visually impaired in a university campus, using the Android based smartphone. The implementation of the proposed system will be done through the integration of Google Map features such as Google Map walking instructions, Google indoor map, Google Map API web services, and Google Map floor plan Marker app with the voice recognition technology and Android TTS (Text-to-Speech) feature. Use of Google Map floor plan Marker app and voice recognition technology ensures more accuracy and secured navigation system.

Keywords: Google Map, Indoor Navigation, Voice Recognition Technology, Text-to Speech (TTS).

INTRODUCTION

Many higher education institutes have taken considerable steps to include the visually impaired students to their campus. But many institutes even in this modern technology oriented world is not getting ready to teach the visually impaired students, because of many factors such as high implementation cost, not sure about the emerging technologies for blinds, afraid to make a change. This attitude need to be changed and the institutes should come forward to take extra steps to provide quality education to the visually impaired students, treating them equal to normal students ensuring them that even the disabled people also have the ability to contribute much to the society in which they are involved.

The paper proposes a voice-based navigation system for the visually impaired, which can be implemented in a university campus. The system will motivate the students to come forward to acquire the education. It assists the blind students to navigate freely across the university, utilizing all the facilities provided by the university like any normal student does. Blind students will be more confident and will get motivated if they can travel independently within the campus.

Many studies have been done on 'the possibility of providing indoor navigation on Google maps' [5]. The proposed system makes use of the different features provided by the Google map like Google indoor map and Google map floor plan marker.

DESIGN

As soon as the user enters into the campus, the mobile application installed in the user's Android smartphone identifies the current position of the user. The mobile application asks for the destination to the user. Then the user provides the destination. Mobile application retrieves the Google walking instructions from Google Map by sending the source and destination to the Google map. These walking instructions are given to TTS module, which direct the user through the voice-based walking directions. Fig. 1 depicts the proposed voice-based navigation system.

Implementation of Voice recognition technology in the proposed system is crucial as it helps the user interact with the
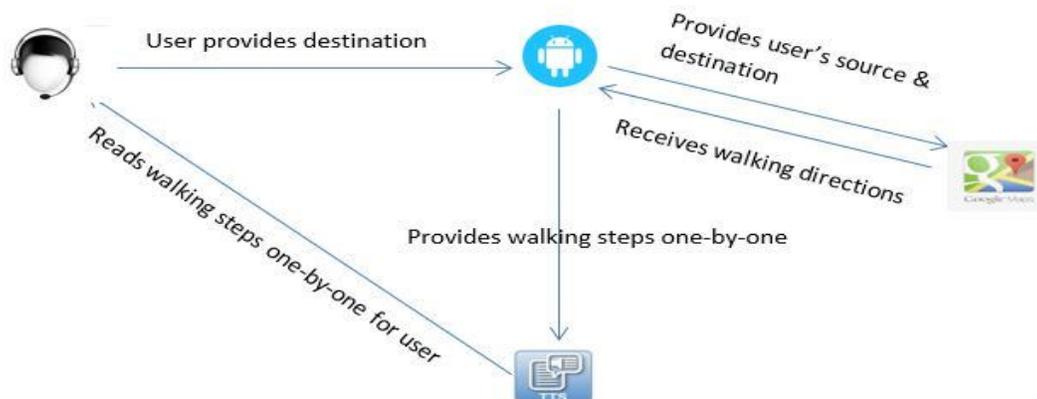

Fig. 1: proposed voice-based navigation system

Android application even in noisy environment, application should recognize and understand the voice and accent of different users. Voice recognition technology involves the identification, understanding and conversion of voice signals into text.

METHODOLOGY

The proposed system has two phases of implementation named phase 1 and phase 2.

Phase 1

Fig. 2 depicts the flow of phase 1.

Fig. 2: Flowchart of Phase 1

Phase 1 deal with the collection of the building floor plans of the whole university campus, which will be available with the concerned property department of the university and then uploading the same to the Google Map using the Google Indoor Map. Working of Google indoor Map has been stated as 'With indoor Google Maps, visitors can spend less time searching for building directories and more time discovering new points of interest. Simply zoom in and out of a building and go floor to floor with indoor maps' [6].

After uploading the building floor plans, align the floor plan with the aerial image of the building. And then to increase the location accuracy of the user who is using this system, make use of Google Maps Floor Plan Marker app.

Steps to accomplish the above three processes are described in [3], which has been summarized below.

Steps to upload floor plan to Google map:

1. Save the floor plans of the university campus as digital image files in your computer. This file can be of any of the formats - .GIF, .PDF, .PNG, .JPG, .TIF, .BMP.
2. Open maps.google.com/floorplans in the web browser.
3. Click on the button 'Add a floorplan now'.
4. Locate the university campus location in the Google map, by issuing the address.
5. Drag the pin to the center of the building and click on the button 'Use this building'.
6. Enter the building floor details in the next screen –Building name, Floor label and Floor number. And then upload the floor plan file. Then click on 'Upload map for this floor' button.

Steps to align floor plan with aerial image of building:

7. Try to align each features of the floor plan like corners and special shapes, to the aerial image of the building in the Google map.
8. When you are ok with the configuration of the floor plan, click 'Save Alignment' button and then click on 'Submit' button.

Steps to increase the location accuracy of the user:

9. **Google Maps Floor Plan Marker app** will get updated with the new floor plan after 24 hours of uploading. Use the Android smartphone to walk inside the building to collect the accurate location information on the way.

Step number 9 increases location accuracy, which is a vital step in navigation of visually impaired. Using 'the Google Maps Floor Plan Marker you can help Google Maps more accurately locate users who are visiting a store, restaurant, venue, or any type of public indoor. The user will walk around the building to collect landmarks, and once it's
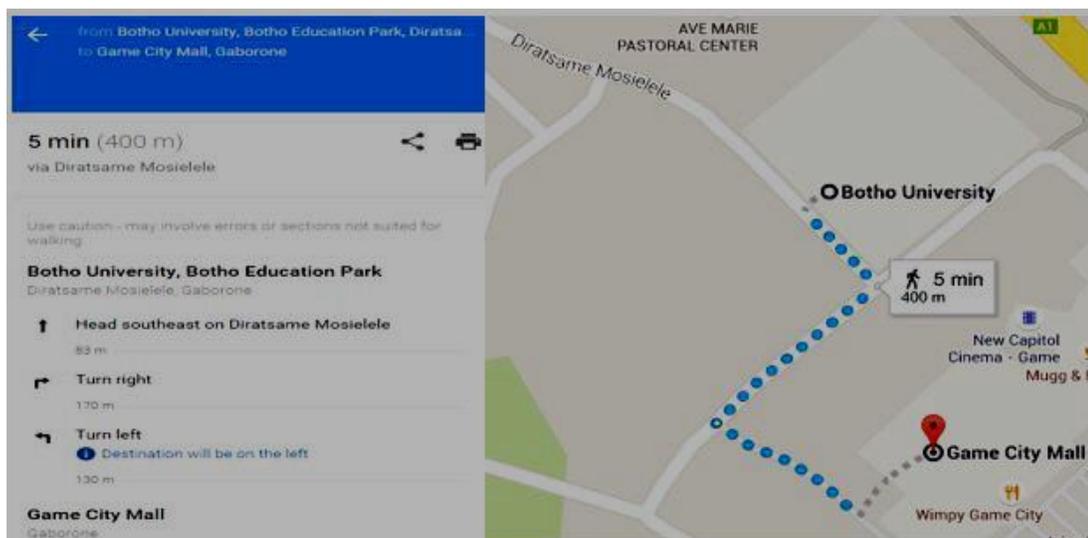

Fig. 3: Google walking directions

uploaded and processed, users of Google Maps for Android will be able to see their location ("the familiar blue dot") in that space when they're inside' [7].

Save Walking directions to Google Map:

Use Google Maps to save or change the walking directions for the floor plan from each source to destination to the Google Map, whose steps are available in [10].

1. Open **Google Map**
2. Click on icon for **Directions**
3. Click on icon for **Walking** Directions
4. Give source and destination for which walking directions need to be retrieved.
5. The walking directions will get displayed. Use the drag option along the walking directions to change the route, in case the route needs to be modified.
6. Click on 'List All Steps' to view the walking direction map along with the navigation steps.

Fig. 3 shows the Google walking directions from 'Botho University, Diratsame Mosielele, Gaborone, South-East' to 'Game City Mall, Gaborone, South-East'. Our proposed system uses the same concept to retrieve walking instructions from a specified source and destination within the university campus.

Towards the end of Phase 1 of the proposed system, university campus floor plan will be ready along with the walking instructions inside the Google Map, which can be used in Phase 2.

Phase 2

Phase 2 deals with the user module, which is the Android smartphone. User is supposed to use the walking cane together with the proposed system to detect any obstacles on his way. Fig. 4 depicts the flow of phase 2 and each steps involved are explained below.

Step 1: The Android application which is installed in the smartphone of the user must be loaded. Proposed system makes use of voice recognition technology for the user to login to the Android application. This can be implemented by using the modules 'Voice information storage' and 'Voice Recognition', described in [1]. First the user's voice information is captured and translated to digital signals, which will then be stored in voice database. And then voice features will be extracted and saved in voice features database. The Voice Recognition module, makes use of this stored voice features to compare with the user's current voice, when the user interacts with the application. So during the login process, application identifies the already registered user and allows the user to login to the application.

Step 2: Application preset the geo codes of the university entrance, using the 'geocoding service' [8] available through Google Maps JavaScript API v3. Application uses the 'geo location' [9] service of Google Maps JavaScript API v3, to retrieve the geocodes of the current location of the user. After the user logged in, the application keeps on checking for the matching geocodes till the user reaches the entrance of the

university campus. And then the application provides a voice-based welcome message to the user, along with the information that the user is in the main entrance. The Google map and android application can be integrated using Google map API key [5]. 'Geocoding is the process of converting addresses (like "1600 Amphitheatre Parkway, Mountain View, CA") into geographic coordinates (like latitude 37.423021 and longitude -122.083739), which you can use to place markers or position the map' [8]. 'The Geocodes were collected using Google maps, Geocodes represent the nodes on the floor plan' [5].

Step 3: The application asks the user for his destination, making use of the 'Speech Announcer' module described in [2]. Speech Announcer 'translates the provided system input into speech and outputs to the user through the speaker' [2]. Here instead of the speaker the proposed system uses the microphone.

Step 4: User provides the Destination to the application through the microphone, which is connected to the user's android phone. Proposed system implements this step by using voice recognition technology, which is also using in step 1.

Step 5: After accepting the destination from the user, the application send both the source and destination to Google Map to get the Google walking instructions, which will be retuning in the form of XML text descriptions. This can be implemented using the Google Directions API which comes under Google Maps API web services, whose details are available in [4].

Fig. 4: Flowchart of Phase 2

Step 6: This step deals with the actual navigation part, which is very important for the visually impaired student to navigate freely in the university campus. The application parses the XML formatted walking directions and then sends the different steps involved in the directions, one by one to the TTS module. Application ensures that the user reaches to each step. While the user move from one step to another, the application keeps on comparing the user's current location's geocodes with the geocodes of the next step. When these two geocodes match, application gives "STOP" message to the user. Then again direct the user to the next steps. And this step-by-step navigation will continue till the user reaches the destination.

The step-by-step navigation part has made more clearer with the help of below given algorithm, followed by the navigation scenario explained with a sample building floor plan and sample walking instruction steps depicted in fig. 5 and fig. 6 respectively.

Algorithm

1. Start
2. Get total steps involved in walking directions and assign this value to variable 'total'.
3. Assign value of variable 'current' as 1
4. While (current < total), perform the below steps.
5. Get the geocodes of step (current + 1)
6. Keep on comparing the user's current location's geocodes with geocodes of step (current + 1)
7. When both the above mentioned geocodes match, application gives 'STOP' message to user.
8. Application gives the (current + 1) direction step to user.
9. Increment value of variable 'current' to 1.
10. Repeat from step 4 to step 9.
11. Application confirms the user on reach of his destination.
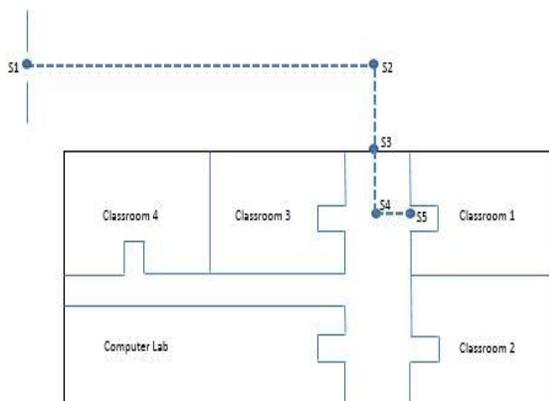12. Stop.

Fig. 5: Sample building floor plan

Table 1 is having the sample walking instructions from the source S1 to destination S5, for the sample building floor plan depicted in Fig. 5. And consider S1 as the source and S5

as the destination of the user, who is navigating in the university campus. As soon as the user reaches S1 which is depicted in fig. 5 as the university main entrance, application gives a welcome message and gets the destination as S5 from the user. Then user directs to S2 with the voice message 'Go straight'. As soon as the user reaches S2, the user gets a 'STOP' message and gets directed to 'Turn right'. As per the given instruction user turns right and continue moving forward towards S3 and when he reaches to S3, user gets the 'STOP' message. Application informs user to "go straight" and when user reaches S4, gives "STOP" message. User then directs to "turn left" and he walks towards S5. User gets "STOP" message, as he reaches S5 and gets the information that "You reached destination".

Table 1: Sample walking instruction steps

Step no.	Steps
1	Go straight
2	Turn right
3	Go straight
4	Turn left
5	You reached destination

Step 7: The user reaches safely to his destination. If the user got another destination to go, all the above steps, starting from Step 3 need to be carried out.

Step 8: User logs out of the application.

All the steps in Phase 2 need to be integrated in the android application which is the heart of the proposed system.

CONCLUSION

Features which can ensure the high-level security of the user who is using this system need to be incorporated in the future. Building plan need to be improved to 3-D maps. The use of the proposed system can be extended to any other public areas where indoor navigation is applicable for the visually impaired.

The advantage of the system is that it can be integrated with the existing infrastructure of any building or campuses where Wi-Fi is already set. Its implementation cost is also less as the user is using his own smartphone along with his walking cane.

Google Maps Floor Plan 'option is currently available in Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Singapore, Spain, Sweden, Switzerland, the UK, and the US'[3]. So as off now this proposed system is suggested only for those countries where this option is available and this can be implemented in future in all the places.

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