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SPEAKING MAP: AN APPLICATION FOR THE VISUALLY IMPAIRED

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ABSTRACT

Map is always helpful for all of us at the time of going from one place to another. At the previous age, people used only a paper map. But nowadays, using maps has become easier because of the availability of smartphones and google maps in it. However, using this map is not possible for visually impaired or blind people. For helping visually impaired people, we have design and implement "Speaking Map" an android based apps which inform the user's current location, nearby places and direction of going from one place to another vocally. It is an android based application system which is developed using 'Android Studio'. We devise and enhance the system by using algorithms by adding more features such as intelligent obstacle detecting ability. In addition, we compare our system with several existing system which confirm better performance of our systems than the other systems. In future, we will adopt for more obstacles and different languages for getting instructions for this map.

KEYWORDS

API (Application Program Interface), Text to Speech, Speech Recognizer, Sensor Event Listeners.

1. INTRODUCTION

Millions blind, 246 million have low vision and 8 to 17 percent of the population is affected by dyslexia (Who.int., 2019) (World Health Organization, 2020) (Bourne et al., 2017). These persons face difficulties reading the signs or directions in the map or recognizing the surrounding environment (Tversky, 1993). But very few technologies are being developed to assist them. There are many navigation applications in the app store but very few of them are helpful to visually impaired and dyslexic persons. In daily life, they need to go to different places as well. But as they cannot read the sign or map, it becomes very difficult for them to reach their desired destination. To solve this problem, we would like to propose our android application "Speaking Map" which is a voice navigation system.

Our proposed system will be able to do the following:

1. Inform the current location of a user both visually and vocally.
2. Inform names of at least 20 nearby restaurants, pharmacies, hospitals, supermarkets, ATMs, hostels both visually and vocally.
3. Instruction set for proceeding towards any of the 20 nearby places.
4. Inform direction for going from one place to another visually and vocally.
5. Instruction set for proceeding towards any destination from the user's current location.
6. Cardinal directions (North/South/East/West).
7. Message after completing an instruction.
8. Alert message to the user when the battery is low.
9. Auto-generated and automatically sent text messages to emergency contacts with the current location when the battery is low.
10. Facilities to call or send an emergency message to emergency contacts when necessary.

All of the information will be given to the user after their instruction. After launching the app, it will say the users to long-press on the screen and give instructions. If a user says 'Help' after long press this app will inform the user about the instruction pattern. If a user says 'where am I?' this app will inform the current location of the user. By asking 'nearby ATMs' this app will inform the user about the ATMs situated nearby to him.

Today's world is a world of technology. We are using technology to make our life easier every day. But very few works are done for the physically impaired persons. A major part of this physically impaired persons is visually impaired. "Speaking Map" is specially made for the people who are visually impaired. This app will help them to know about their current location, nearby ATMs, hospitals, restaurants, hotels, markets, etc. It will also help them to inform the direction for going from one place to another. The aim of this app is to help a blind person to walk alone while he/she has no one to help.

2. RELATED WORKS

Getting instructions vocally on the map has allowed the visually impaired people to navigate the streets and reach their destination safely. In this project, we have developed an application where users can interact vocally with it from the opening of the app rather than pressing a button like the existing system. We had studied previous works on this kind of vocal map to explore the features of it (Google, 2019) (Forbes.com., 2019) (Al-Heeti,

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A., 2020). Besides giving the voice instruction to reach the destination and notifying a user about current location like the other existing systems, this app will assist to find out the nearby restaurants, hospitals, supermarkets, pharmacies, ATMs, and hotels by voice instructions and reach the place. For the safety issue of the visually impaired person while traveling this application will give an alert message to the user when the battery is low. Not only this but also auto-generated text message will be sent to the emergency contacts with current location at the time of the low battery. Facilities to call or send an emergency message to emergency contacts are also available in this application. Integrating the features of voice direction as well as safety-related caution it is hoped that using this system will make a user more comfortable and confident while traveling.

3. Software Developments

Using the following scenario, we explain our model.

Suppose a visually disabled person needs to go to an unfamiliar place or wants to know the nearby surroundings of his current location. He will need step by step instructions including cardinal directions to guide him. As he is visually impaired, he will need to be notified every time he completes an instruction. In case of any emergency, he needs the facility to communicate with some trusted people to ask for help. And in emergency situations like in case of insufficient battery he needs to be notified. And all of this must occur through voice input-output only. However, no such application completes the whole task.

Considering these issues, we felt the necessity to develop an application in order to assist the visually impaired. Our model can help with this matter. Figure 1 shows the conceptual model of "Speaking Map".

The application uses several Google APIs including Google Places API (Google Cloud, 2020), Google Maps API (Google Developers., 2020), and Google Direction API. Google Maps API provides the necessary map tiles for the application. Google Places API provides nearby places. Google Direction API provides directions. And the cardinal directions are provided using the device Rotation Vector, Accelerometer, Magnetometer. These sensors event listeners provide the Azimuth of the device. The voice input is handled with Android's Speech Recognizer Class, and the voice output is delivered using Android' Text To Speech Class.

4. Designing Components

This research is to assist visually disabled people in their travel utilizing their ability to hear. In the application, we have used,

- Sensor Event Listeners
- Google Places API
- Geocoder
- Google Directions API
- Speech Recognizer
- Text To Speech

5. Working Procedure

The result of the application is received from Google API and the Sensor Event Listeners. While the voice communication is handled by Android's Speech recognizer and Text To Speech Classes. The user will open the application using Google Assistant. After the application starts, it will greet the user and give instructions to use the application through voice. The user will have to long press and ask his question, the application will process the query. For a valid query, the application will collect results using Google API and deliver the results through Android's Text To Speech. In emergency cases, the application will inform the user to send text messages to emergency contacts. The user can also request to call a number.

To get the user's current latitude and longitude the application uses GPS, using these values the application calculates the current location with the help of Geocoder.

To get nearby places the application uses Google places API with current latitude and longitude.

To get direction for any place the application uses Google Direction API with the latitude and longitude of source and destination.

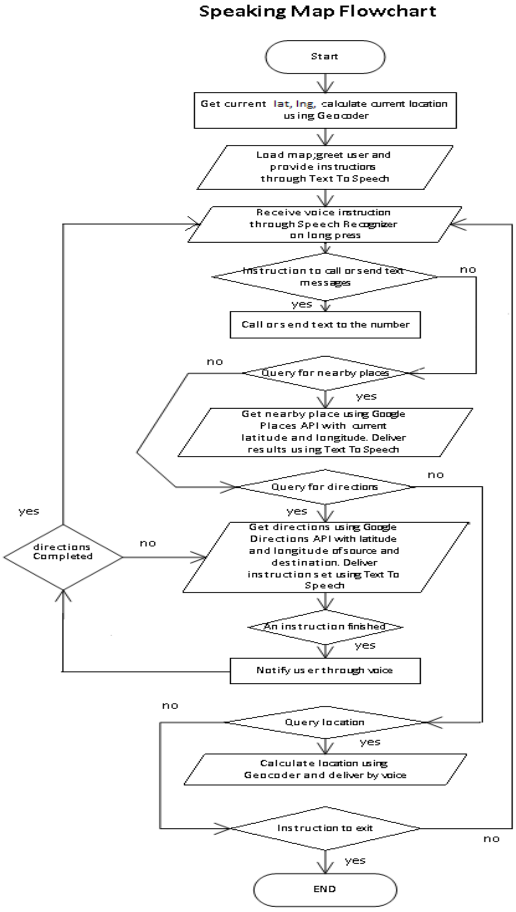

Figure 1: Flowchart of Speaking Map

6. Algorithm Analysis

The application runs on two separate algorithms. The first algorithm computes the results of the query, while the second algorithm delivers the result and receive queries through voice. If the query is about the current location, the application uses geocoder and calculates location with latitude and longitude received from device GPS. If the query is about nearby places the application uses Google Places API to derive the results. If the query is to get the direction the application gets the direction from Google Direction API with source and destination latitude and longitude.

The results are delivered using Android's Text To Speech class

```
if(mAzimuth>=340 || mAzimuth<=20){
    facingWay="North";
    north="front";
    south="back";
    west="left";
    east="right";
```

Figure 2: Partial Code to Get Cardinal Directions

```
s=s.toLowerCase();
if(s.indexOf("which way am")!=-1){
    boolean speakingEnd;

    speak( s: "You Are Facing "+facingWay);
    speakingEnd = myTTS.isSpeaking();
    do {
        speakingEnd = myTTS.isSpeaking();
    } while (speakingEnd);
```

Figure 3: Partial Code of Voice Output

```
private void getDirections() {

    String key= getString(R.string.google_direction_api);
    urlString= String.format("json?origin=%s&destination=%s&mode=%s&alternatives=true&key=%s",
            origin,destination,mode,key);
```

Figure 4: Partial Code to Get Directions from Google Directions API

7. Comparison With Existing Systems

Comparison table between "Speaking Map" and other existing android systems is given below

Table 1: Comparison table between "Speaking Map" and other existing android systems

Features	"Speaking Map"	Other existing systems
1.Need of button press for operating		✓
2. Taking vocal instruction	✓	✓
3.Vocal Road direction to go to a place	✓	✓
4.Cardinal direction	✓	✓
5. Alert SMS at low battery condition	✓	
6.Automatic sent of SMS at emergency	✓	
7. Call to the emergency contact	✓	
8.Making users concern if the road is busy with traffic		✓

From the above table, it can be seen that in this "Speaking Map" there is no need for button press but other existing android systems need so. But it is not easy for a visually impaired person to know the position of the button on a mobile screen. So, it will be more comfortable for the users to use the "Speaking Map" as a blind navigation mobile app, again the features for the emergency period are also additional in "Speaking Map" which are not available in other voice navigation apps.

Previously some applications were used for indoor wayfinding like BLE-based NavCog smartphone applications (Ahmetovic D et al., 2016) or purely initial prototypes (Apostolopoulos I et al.,2012). But our system is for mainly outdoor uses. On the other hand, Seeing AI (Microsoft.com, 2020) or TapTapSee (Taptapseeapp.com, 2020) provides users with a verbal description of captured images, while our app describes the directions from one's current location towards the desired location. The vOICE observed volume-to-brightness and pitch-to-spatial height (see "weak synesthesia" in (Martino G et al.,2001)) (Real et al.,2019).

We took advantage of perceptual and cognitive factors associated with non-visual information processing (Loomis J.M et al,2012), (Giudice N.A.,2018), (Real et al.,2019). Our system's uniqueness is its ability to operate completely by using voice.

8. Result

The application was practically applied for demonstrating its effectiveness and the result was up to the mark. For checking the effectiveness, 10 visually impaired users had volunteered to use the application. Five of the users were examined while using the application and the other five were examined while not using the application on the same road.

In this experiment, users needed to pass a distance of 3 minutes indicated by the map which is shown in figure 5.

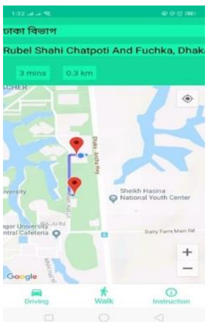

Figure 5: Distance passed by the users during the experiment.

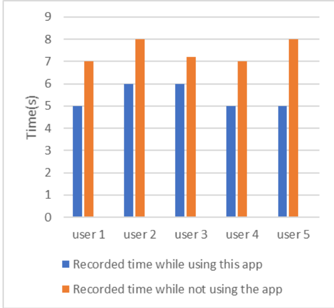

Figure 6: Graph showing the recorded time of the users while using the app for passing the same distance.

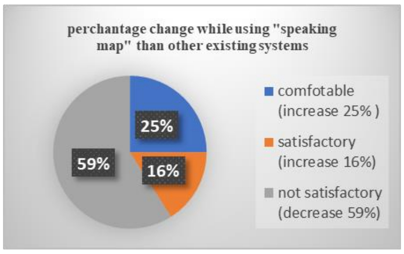

Figure 7: Pie chart for showing feedback of users in percentage after using the application.

A graph in figure 6 shows the recorded time of the users while using this application as well as not using the application.

It is observed that the users who did not use this application reached destination within 7.44 minutes while the users who used this application reached the destination within 5.4 minutes on average.

So, it can be clearly seen that using this application for going in the same direction is helping a visually impaired user to reduce the time of travel. Most of the users also said that they felt more relax on the road while using the application.

There is a pie chart in figure 7 which is made according to the feedback of the users of the app.60% of the users said it is comfortable and helpful while walking on the road. The other 30% said they need additional features such as obstacle detection system and the rest of the 10% user were not satisfied while using the app.

To observe the comparison between "Speaking Map" and the other existing systems another pie chart is given in figure 8 to show the feedback of people after using other systems.

From the pie chart, it can easily be seen that using "Speaking Map" is more comfortable for users than other existing systems.

If a percentage calculation is done between the two pie charts areas of figure 7 and figure 8 of the "Speaking Map" and other existing systems, it is found that 25% of users has increased in the region of "comfortable and helpful" portion of the pie chart of "Speaking Map", almost 16% of the users has increased in the region "satisfactory" portion of the pie chart of "Speaking Map" and almost 59% of the users has decreased in the region of "not satisfactory" portion of the pie chart of "Speaking Map". The changes in the percentage calculation is shown in the pie chart in figure 9.

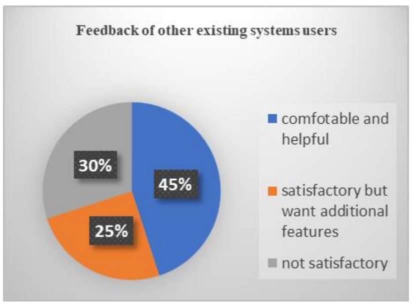

Figure 8: Pie chart for showing feedback of users in percentage after using the application.

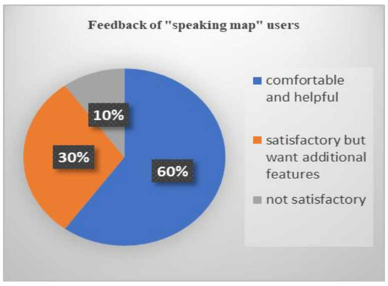

Figure 9: Pie chart for showing the percentage changes between the users of "speaking map" and "other existing systems".

9. Future Enhancement

Currently, this system is interacting with the users by only the English language. Adding multiple languages will make this system more acceptable and usable to the visually impaired people all over the world. We are interested to add multiple languages specially Bangla in this system. We also want to make this app usable in the offline mood too. Again, intelligent obstacle detecting (Xie, M. et al.,2020) feature will make the users more secure and confident while using this system for going from one place to another place. So, this will be our great concern as the future enhancement of the system.

10. Conclusion

Walking towards an unknown place is difficult and it is more difficult for the 36 million people who are blind worldwide or for the 217 million people more who are suffering from moderate-to-severe vision impairments. This project is done with an aim to help the visually impaired people while they travel from one place to another by giving instructions vocally. In addition, we measured our performance and compared with several existence system. Results show that our system is more efficient than other systems. In future, we will modify it more trustworthy, secure, and easy to the users by adding intelligent obstacle detection feature and multiple language support. Finally, we expect that this android designed talking map will improve the quality of life for the visually impaired and this system will help the visually impaired people all over the world like the trustiest friend on their journeys.

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