Emerging Engineering and Mathematics, 3023-3348
Volume 2023, Article ID 24
doi: 10.23958/eem/vol2023/24

Research Article

Non-Visual Interaction using Voice Control for Visually Impaired

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Abstract

In this paper we introduce Voice Control Device (VCD), which provides non-visual access to the Android Operating System. It offers many contributions in the application. Firstly, it enables system wide Voice Control and can accommodate any application. Secondly, it can construct many commands which the user can easily use, and lastly it is very efficient and natural way of interaction with the user which provide many features. The two main features used in this application are Text-To-Speech which converts digital data or text in the form of speech and Speech-To-Text which converts speech in the form of text or digital data which the application can process internally. These features are very helpful for visually impaired people. Using these features user can access other functions of the application like Current Location, Navigation, Assistant, Calling Guardian, Texting, Google Map features etc. The main function which user can use is that they can listen to the surrounding so that they can visualize the scene in their mind and travel on road by getting the analyzed data from the smart cane connected to the phone.

Keywords: ***Voice Control Device, Visually Impaired Individuals, Non-Visual interaction, Android Application.***

1. Introduction

1.1 Problem Statement

Graphical User Interface (GUI) such as buttons, menus and documents are presented for users so that they can interact using these GUIs. There are two types of interaction. First is Visual Interaction and second is Non-Visual Interaction. In visual interaction people can see the screen and can directly interact by giving specific commands and follow up on those commands, which is the main reason that it is difficult for visually impaired people. In order to ease this difficulty Voice Control Device (VCD) is used specifically for visually impaired people so that they can easily interact with the device. For this problem the Speech Recognition Engine is used. While travelling the visually impaired people face many problems like traffic on the street, pedestrians on footpath, unpredictable objects coming in their path, etc. To overcome this problem, the analyzed data is received from a smart cane consisting multiple sensors and camera in the Android application which the user can hear using earphones and follow them while walking outdoors as well as indoors.

1.2 Literature Survey

For the literature survey of various related technologies, that are used to make the use of applications easier for visually impaired individuals, we have collected and commented on a few of such technologies.

1.2.1 Speech-To-Text Based Life Log System for Smartphones

The technique used in this case is Microphone of Smartphone, STT (Speech-to-Text), Regarding the given reference, we have noticed that users are able to search life log sound files using text.

1.2.2 Voice control of home appliances using Android

The technique used in this case is Voice commands are used to ON/OFF home appliances, Regarding the given reference, we have noticed that it needs extra hardware to ON/OFF electrical appliances

1.2.3 Voice Helper: A Mobile Assistive System for Visually Impaired

The technique used in this case is support of voice command for visually impaired persons. Regarding the given reference, we have noticed that call/SMS is not handled through voice.

1.2.4 Android based Automated Smart Wheel Chair

The technique used in this case is android voice command used to move wheel chair. Regarding the given reference, we have noticed that it works over Wi-Fi and uses extra hardware to control Wheel Chair

1.2.5 Enabling universal voice control on Android

The technique used in this case is used to launch android applications via voice commands. Regarding the given reference, we have noticed that call/SMS is not handled through voice.

1.2.6 GPS enabled the Android application for Locale Bus Schedule System

The technique used in this case is GPS used to find user's current location and also to check the bus schedule. Regarding the given reference, we have noticed that user can check the timing and route by directly searching for the bus number.

1.2.7 Interactive Voice Response System for Single Phase Motor Protection, Control & Alert using GSM Mobile with Android application

The technique used in this case is controls on/off of electrical or electronic appliances from anywhere in the world. Regarding the

given reference, we have noticed that application uses SMS feature to remotely control the equipment.

1.2.8 Smart Home Automation System using Android application
The technique used in this case is home appliances can be monitored and controlled. Regarding the given reference, we have noticed that user can also interact with the system.

1.2.9 An Event Driven Campus Navigation System on the Android platform
The technique used in this case is this system works on the principle of Virtual Cloud Computing. Regarding the given reference, we have noticed that user will also get notifications related to the event.

1.2.10 Real time Transportation System and Location Tracking using Android application
The technique used in this case is the detailed information like bus number, timing, routes, current location, etc. will be given to the user. Regarding the given reference, we have noticed that application is user friendly and this platform is more feasible than others.

2. Project Scope

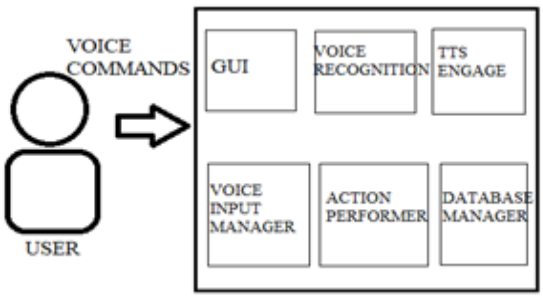
1.1 Introduction
In this android application the user can access many services of smart phone using voice command. The user can send message or call anyone in their contact list or they can also give the number manually. Some other features provided by voice control device is alarm, current location, Google search, Navigation from one place to other, emergency call, accessing other applications on their phone, etc. The main feature provided by this application for visually impaired person is that while they are travelling on street or footpath, they can access the analyzed data fetched from the smart cane and get a detailed information about their surrounding and can walk accordingly.

1.2 Aim
- To develop a Voice Controlled Android application.
- To develop efficient user interface for a proper interaction between user and phone.
- To help Visually Impaired people for travelling efficiently both outdoors and indoors.

1.3 Objectives
- To handle both Incoming and Outgoing calls.
- To handle both Incoming and Outgoing SMS.
- To handle basic operations using Voice Control.
- To fetch the analyzed data from the smart cane.
- To use this data for the travelling purpose both outdoors and indoors for visually impaired people.

3. System Design

3.1 Proposed System
Below diagram gives a brief idea about the System Architecture:



3.2 Main Modules
3.2.1 ***GPS:*** *The Global Positioning System (GPS) is a satellite-based navigation system. It provides many features like geolocation and global time on or near the Earth.*

- It is used in determining the current location of user.
- Monitoring the object or personal movement of the user.
- Creating maps of the world.
- Navigation from source location to target location.

3.2.2 Text to Speech: It works on the principle of Speech Synthesis Markup Language (SSML) which is based on the Java Speech Markup Language (JSML).

- In this function Text-to-Speech API is used which converts digital data or text in the form of speech.
- This audio will be helpful for a visually impaired person as they can hear the process going on in their application and also be able to hear the responses of their search or command from the application.

3.2.3 Speech to Text
- Speech-to-Text API is used which converts input audio or speech into text form.
- This function can be used to follow any command given by the user to the phone like texting or calling someone from the contact list or by giving a manual number.

3.2.4 Voice Input manager: This manages the commands given by the user to the phone and it stores all these commands in the database manager. The database manager compares all the audio data from the database and then gives response accordingly to the action performer.

3.2.5 Action Performer: This fetches all the response from the database manager as input and then it decides that which action should be performed. The action can be in the form of message or calls.

- Text Message: The user can send any message to a specific person in the contact list by giving the command and the application should send it directly to the receiver.
- Calling Service: The user can call anyone in the contact list and also by giving any number manually by giving the command and the android application should successfully call the person directly.

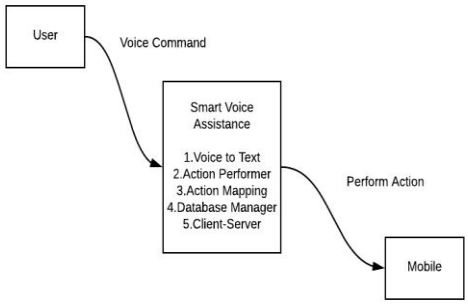
3.2.6 Client-Server: In this the Android application will fetch the analyzed data from the web server and will communicate this information to the user using Text-to-Speech.

- The data on the web server is uploaded by the Raspberry Pi which is connected with the Camera module, Ultrasonic sensors and Depth sensor.
- This data is read by the Raspberry Pi through GPIO pins and then are uploaded on the web server.

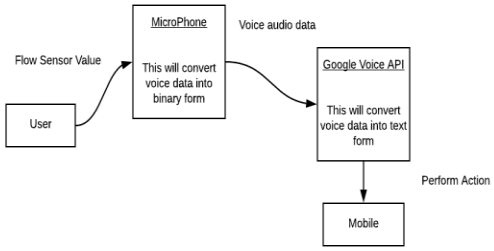
4. System Analysis

4.1 Data Flow Diagram: It is the graphical representation of flow of data or information through an information system. It is the preliminary step in creating the overview of the system.

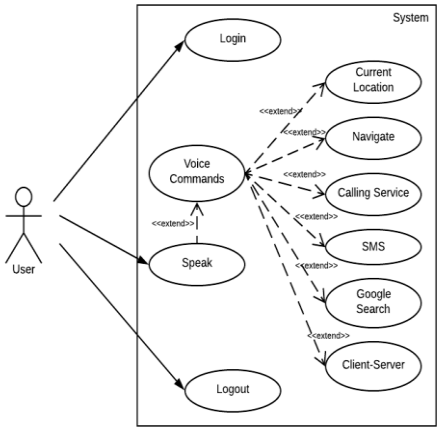
- Level 0: The input is in the form of voice, and is recognized by the application. Then action is performed according to the voice command given.



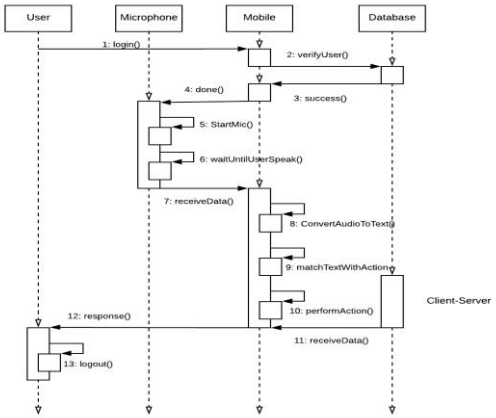
• Level 1: The input is given through microphone in the form of voice. This input is converted into binary and then the Google Voice API converts this input into text form and actions are performed according to the command given.



4.2 Use Case Diagram: This diagram consists of actors and actions performed by them. In our project there is only one actor which is the user and they perform functions like speak, calling, texting, client-server, etc.



4.3 Sequence Diagrams: It helps us to understand that in which sequence the activities are working in the application.



5. Feasibility and Mathematical Model

Android Based Smart Voice Assistant: It is given a failure case because of invalid http request detection, or voice command not working, we devise an algorithm for this problem as follows:

- For a Problem P1 to be NP-Hard, Satisfiability problem (SAT) must be reducible to P1; SAT P;

  Let the propositional formula be: G = X1 ^ X2

- Where X1: It will be true if the input HTTP Request is invalid

  X2: True if Voice Command is not available

  Algosati ()

  For i: 1 to 2
  Xi = Choice (True, False);
  If G (x1, x2) then
  Success ();
  Else
  Failure ();

- Therefore, since the problem will become a decision problem, it will be NP.
- 3SAT problem is NP Complete. The system can be reduced to 3SAT problem. A 3SAT problem takes a Boolean formula S that is in CNF in which each clause has exactly three literals. 3SAT is a restricted form of CNF-SAT problem.

- X1-Input Voice Handler
- X2-Action Performer
- X3-TTS Engines = (x1 ^ x2 ^ x3)

  Algosat ()

  For i= 1 to 3
  Xi=Choice (true, false)
  If (S(x1, x2, x3) = true)
  Success ()
  Else
  Failure ()

As it is polynomial time. It is NP-Complete.

6. Conclusion

In this paper we have presented the system design and use cases of universal voice control assistant on Android operating system. The contributions of the Voice Control application are twofold. First, it provides enhancement to all applications and by recognizing the voice and command given it performs actions according to the commands.

Chaining of multiple commands enables more natural and seamless interaction experience. Second, it also provides an analyzed data of the user's surrounding by fetching this data from the smart cane carried by visually impaired people.

Using this it will be easy for the user to travel outdoors and indoors as they will form an imagination on the basis of the description and commands given by the application to the user. Speech recognition technology is the key for humans to interact with the machines.

This Application is very useful for visually impaired people as it requires no physical contact with the screen and also saves time.

This application also provides Text-to-Speech for blind people if they want to receive the contents of the documents or read out any message or mail stored in the mobile.

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