

Braille and Voice Based Mobile Device for The Blind

¹Arvind Singh Choudhary, ²Dr Ravi Gupta
Assistant Professor, Assistant Professor
Dept.of Computer Science & Engg.
Govt. Engineering College
Bharatpur, India

Abstract— In present era smartphone market is growing rapidly. But the visually challenged persons are not able to access the general features of smartphone such as appointments, tasks, reading and writing SMS, checking - battery power status, current time and date, network status. A part from this they are unable to adding contacts, making calls and accessing music player.

In this paper, Blind user inputs text command and receive speech- output as response. Buttons (in case of event handling in .NET compact framework) [2] for charactes and commands are placed on touch screen[2] of the Smartphone (Windows Mobile)[15][16] and Braille overlay[3][4] is placed on touch screen. When user touches any character or some commands, respective character or command will be read aloud as feedback so that user can be assured for correct input. For reading aloud text messages, Text to Speech sytem[5][11][6] is there which converts text into audible form. The text is read aloud by audio player. Related work done by some other researchers, is limited to audio access to smartphone[1]. There is no provision to input text using Braille.

Index Terms – Windows Mobile, Braille, Text to Speech Synthesizer, Accessing mobile phone by the Blind , .Net Compact Framework

I. INTRODUCTION

For each request of the user, speech output is produced. Many times, the output is produced in text form. So text to speech synthesizer is required to convert text into speech[5][11][12]. Microsoft has designed an interface called SAPI (Speech Application Programming Interface)[6][14] which supports dynamic speech input and output, and integrated it in its current operating system. With the API it is possible to develop speech-enabled applications without caring about the details of synthesis and recognition. It is common all over world that one braille code has 6 points. With the combination of 6 points, 64 characters can be expressed by one cell. If more than 64 characters are to be encoded, then 2 cells are used like a shift code system. In this work, I have used only 46 characters (including buttons), so one cell is sufficient to each character. Buttons are treated as a character or a command here. All the buttons are placed on touch screen. The blind can identify the characters (or Buttons) by touch.

II Goals

Specifically, this research paper describes how to perform following activities by the Blind by giving text commands-

1. *To save a new contact*
2. *Dealing with SMS Received*
3. *Reading aloud an Unread SMS*
4. *To save new SMS to Read directory*
5. *To read aloud an old SMS*
6. Add an appointment with start date and time
7. Read aloud all appointments for a given date
8. Add a task with “due date”
9. Read aloud all tasks available in the Smartphone
10. Delete a task after completion
11. Add a new contact with contact name and cell no
12. Making a Call

13. Read aloud current date, current time and current day
14. Read aloud battery status
15. Read aloud network status
16. To play a song using Audio player

III. PRAPOSED SOLUTION AND IMPLEMENTATION

The blind cannot use smart's phone keypad to input text commands. But the touch screen can be behaved as a keypad by placing buttons on it and by providing functionality of keys to them. Actually, an overlay will be placed on the touch screen of the smart phone. This overlay will give feel of Braille keypad. By touch this overlay, it can be easily known-“Which key, the finger tip is going to access?”

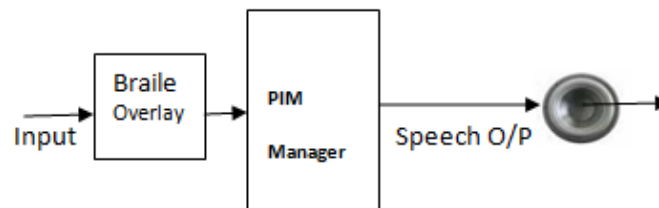


Figure 1: Block Diagram of the Application

Similarly, the blind can't see the results on output screen but he can listen the results. Therefore, voice interface is to be created. So that the blind can access results, progress messages and exceptions.

(1) *To save a new contact-*

It represents a Contact item in the Contact collection[8]. Contacts represent information records of friends, colleagues, acquaintances, or even a company. They can be used for a variety of purposes (for example, addressing mail, e-mail, and text messages). A sizable Contact collection containing richly populated Contact items, is an enormously powerful database.

A Contact is a specialized PimItem. The ContactCollection is used to add and retrieve Contacts to and from the Contact folder.

If a person is to be called or an SMS is to be sent to the person and the person's contact details are not added to contact collection ever before, then contact name and cell no (10 digits) can be saved to contacts. There may be two cases arise-

Test case1- any one of 10 characters in cell no is not digit. In this case, the software must say –“all characters of a cell no must be digits”

Test case2- the contact name already exists. In this case, the software must say-“the contact name already exists please try again with another contact name”

Test caes3- both cell no and contact name are received correctly. In this case, the software will speak- “the contact has been added successfully”.

(2) *Dealing with SMS Received* - When a new SMS[7] arrives, it is received in a Text Box as shown in fig. 2, the ring tone is played by audio player immediately and it is stored in UnRead directory along with sender's name depending upon whether the sender already exists in Contacts[8].

When a text message S is received, the sender's number SN is retrieved[2]. Then contact collection is searched against SN. If SN exists in Contacts, then Sender's name is appended to the received message to keep track sender's name along with SMS. If SN does not exist in Contacts, then Sender's cell no itself is appended along with SMS. After preparing SMS, it is saved in a file with file name <x>.txt (where <x> is some number) in the UnRead directory (The Unread directory holds unread messages and Read dir holds old messages).

Test cases – Possible test cases are as follows for receiving an SMS -

When a new SMS is received. There are two possible cases to be considered-

Test case1- it may be that received message is blank. In this case, SMS is not stored with sender's name in UnRead directory.

Test case2- a non blank message is received. In this case, the SMS is stored in a file with sender's name in UnRead directory

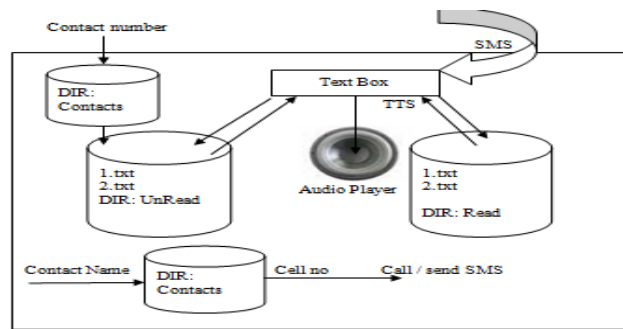


Figure 2: Various Directories and files to store SMS

(3) **Reading aloud an Unread SMS**- When an unread message is read aloud by pressing “up” soft key, the message that is received at last will be read aloud first. After reading an unread SMS, the file consisting that message from UnRead dir is deleted and the user is prompted to save the message in Read dir by pressing “down” soft key[2]. If user does not press “down” soft key, the message will be automatically deleted permanently.

Test cases - To Read aloud an Unread SMS. Following test cases can be produced for this activity-

Test case1- if there is no more messages to read. In this case the software must say-“the total number of unread SMS are 0”

Test case2- if there exists some messages in UnRead directory. In this case, the software must say-“the total number of unread SMS are <x>, where <x> denotes some number” and then most recently received SMS is read aloud.

(4) **To save new SMS to Read directory** (After reading aloud) by pressing “down” soft key. There may be two cases appeared-

Test case1-the SMS is a blank SMS. In this case, the software must say- “a blank message cannot be added to Read directory”.

Test case2- the SMS is not blank. In this case the SMS is saved in Read directory and software says- “the message has been added to read directory”

(5) **To read aloud an old SMS** with sender's name or sender's number by pressing “right ” soft key[2]. Each time while “right” soft key is pressed, only a single old SMS will be read aloud. If there are 5 old SMS in Read directory, then to listen all SMS, “right” soft key must be pressed 5 times also. There may be two cases can be seen-

Test case1- All SMS in Read directory has been read aloud one by one and there is no more messages to be read aloud. In this case, the software must say – “there is no more messages in read directory”.

Test case2- there exists some SMS still to be read aloud. In this case the software should read aloud –“this is message number <x> out of <y>, where <x> and <y> are some numbers”.

(6) **Addition of an appointment** - the software must take start date, start time as well as subject of the appointment. Start date must be in yyyyymmdd format and start time must be in hhmm format and appointment subject should be inputted followed by a hash (#).

1. Test case1 – when start date does not have 8 characters. In this case, software must say-“there is an error ,the start date is invalid, please reenter the date”.

2. Test case2 – when any of 8 characters in the start date is not a digit. In this case, the software must say-“there is an error, all characters in a date must be digits”.

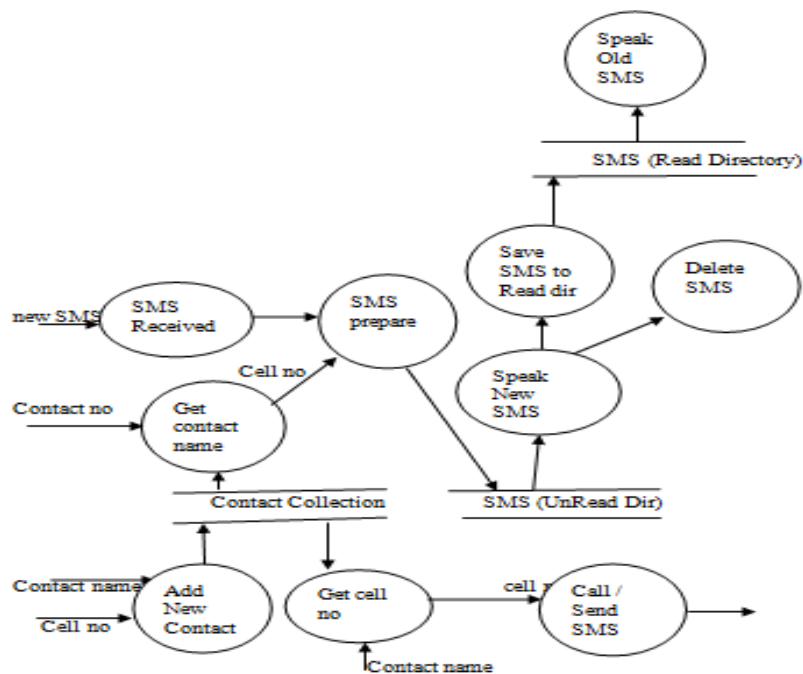


Figure 3: DFD representing Application's functionality

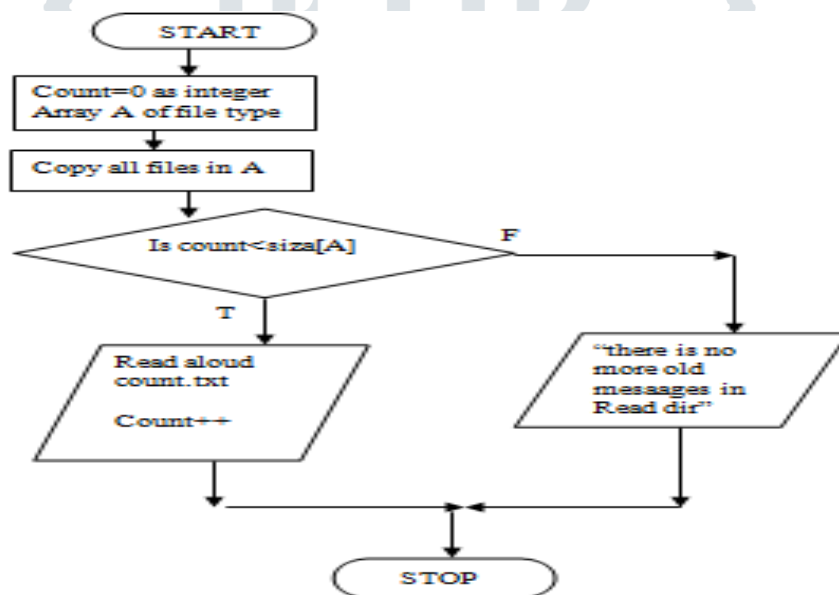


Figure 4: Flowchart to read aloud old messages

3. Test case3 – when the start date is earlier than today. The software must say-“there is an error, the start date of the appointment is earlier than today”.
4. Test case4 – when start time does not have four characters. In this case the software must speak-“there is an error- the start time has less than four characters”.
5. Test case5 - when any of four characters is not a digit. In this case, the software must say-“there is an error, all characters in the start time should be digits”
6. Test case6- when both date and time are not in valid format. In this case, the software must say-“Enter appointment subject followed by #”.
- (7) **To read aloud all the appointments** for a given start date, the software must take a date as start date in yyyyymmdd format. Following test cases can be produced for this activity-

Test case1 – when start date does not have 8 characters. In this case, software must say-“there is an error ,the start date is invalid, please reenter the date”.

Test case2 – when any of 8 characters in the start date is not a digit. In this case, the software must say-“there is an error, all characters in a date must be digits, please reenter the start date”.

Test case3 – when the start date is earlier than today. The software must say-“there is an error, the start date of the appointment is earlier than today, please reenter the start date”.

There may be multiple appointments for a given date but with different start times. Flow chart to read appointments for a given date is shown in fig. 3.

(8) **To add a task**, the software will take due date for the task. Following test cases can be produced for this activity

Test case1- when due date does not have 8 characters. In this case, software must say-“there is an error, the due date is invalid, please reenter the due date”.

Test case2 – when any of 8 characters in the due date is not a digit. In this case, the software must say-“there is an error, all characters in a date must be digits, please reenter the due date”.

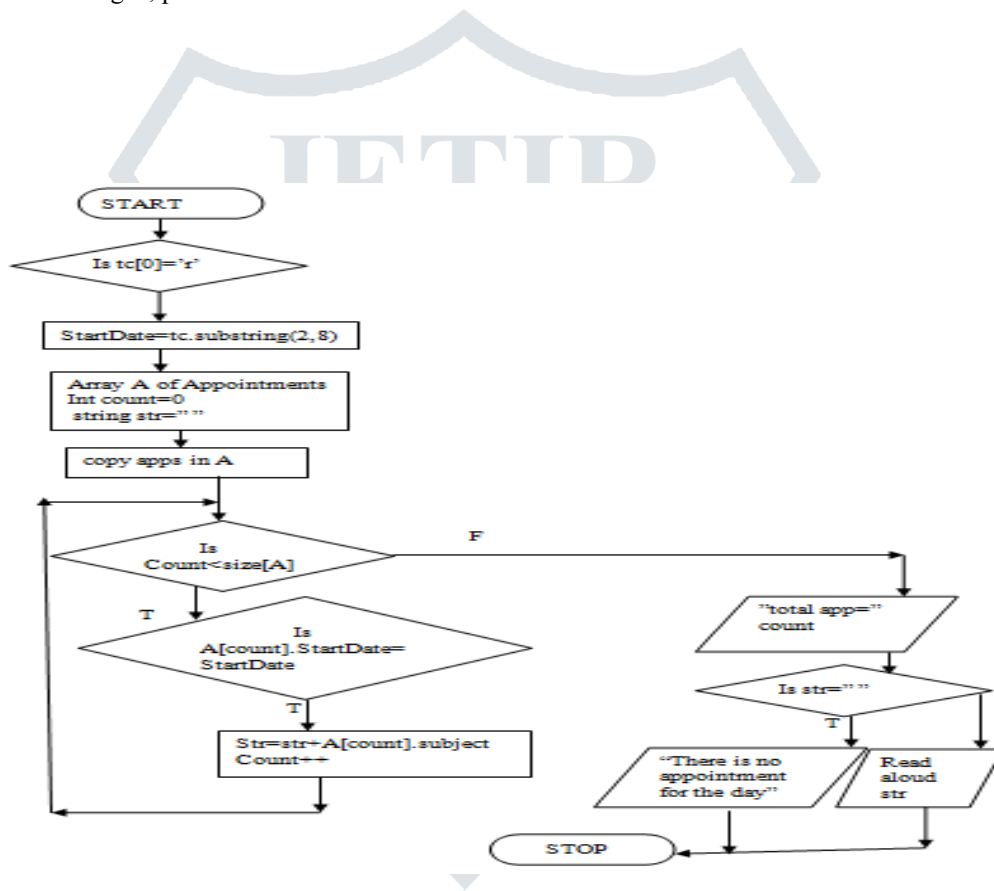


Fig. 5: Flow chart to read appointments for a given day

Test case3 – when the due date is earlier than today. The software must say-“there is an error, the start date of the appointment is earlier than today, please reenter the due date”.

Test case4- when due date is in correct format. In this case, the software must say-“Enter task subject followed by #”.

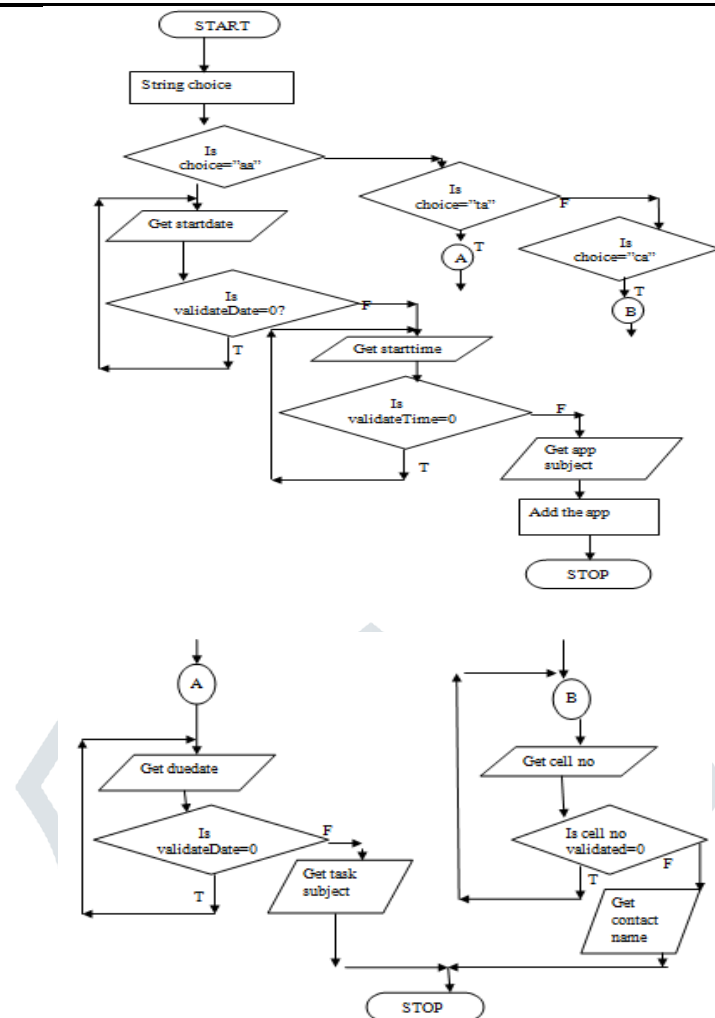


Fig. 6: Flow chart to add PIM data

(9) *To read aloud all the tasks*, the software will take nothing as input. It reads aloud all tasks with their due dates. By just selecting this activity, tasks will be read aloud tasks one by one.

(10) *After listening a task*, the user can delete the task by entering text command “deltask”

(11) **To save a new contact-**

It represents a Contact item in the Contact collection[8]. Contacts represent information records of friends, colleagues, acquaintances, or even a company. They can be used for a variety of purposes (for example, addressing mail, e-mail, and text messages). A sizable Contact collection containing richly populated Contact items, is an enormously powerful database.

A Contact is a specialized PimItem. The ContactCollection is used to add and retrieve Contacts to and from the Contact folder.

If a person is to be called or an SMS is to be sent to the person and the person’s contact details are not added to contact collection ever before, then contact name and cell no (10 digits) can be saved to contacts. There may be two cases arise-

Test case1- any one of 10 characters in cell no is not digit. In this case, the software must say –“all characters of a cell no must be digits”

Test case2- the contact name already exists. In this case, the software must say-“the contact name already exists please try again with another contact name”

Test case3- both cell no and contact name are received correctly. In this case, the software will speak- “the contact has been added successfully”.

(12) *Making a Call* - If user needs to call a person, the call can be made by name as well as by cell number.

(a) Call by Name - The person name is inputted then press “Call” button. The contact collection is searched against the person name. if search completes successfully, the call starts with reading aloud a message-“your call is under progress”. Otherwise, another message will be read aloud –“The contact name does not exist in Contact collection”. (if no input is made then the software must read aloud-“Please enter a contact name first”).

(b) Call by cell Number – the cell number is inputted with ‘@’ as the first character, then “call” button is pressed. A message is read aloud if number is valid-“your call is in progress”.

Flow chart to call a person either by contact name (if it is already saved in Contacts) or by cell number is as follows: (13)-(15) This module is devoted to read aloud the current date, current time and current day (“ddt” button), to read aloud battery status (“bat” button) as well as to read aloud network status (“nw” button), whatever we select among them, is read aloud. There is no input needed.

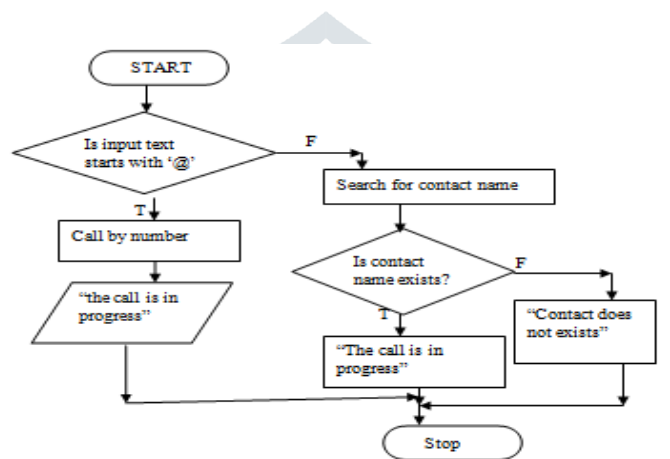


Fig.7 : Flow chart to call a person

It is very important to preserve battery life as much as it can be. Because battery powered devices are dead if battery has completely been drained. So developer should develop battery friendly applications.

Basically to get battery status and to read aloud it, “bat” button is pressed. Battery power in percentage may be in range from 0 to 100. Therefore, for each value, there should be a wav file so that the value can be read aloud.

To cover all this range we must have wav files for 0 to 9 and for 100 itself. Suppose battery power is 67, then we are to interpret this value so that we can have both digits 6 and 7. We can concatenate these two digits to make it as a string. As all wav files are named according to their values for example for the previous, 67.wav file will be searched that is stored in the storage card of the device.

Algorithm-

The software is up and running and waiting for an input to know remaining battery power-

Step 1:- Whenever user wants to know the remaining battery power. He / She has to press appropriate button.

Step 2:- Registered event handler handles the event when a button is pressed. It reads the battery power remaining

Step 3:- The value of remaining battery power is interpreted in such a way that all the digits of that value are separated, and

Step 4:- These digits are concatenated to form a string and after this string “.wav” is also appended. For example, the value of remaining battery power is 67. After interpretation and appending “.wav”, a new string “67.wav” is formed.

Step 5:- As all the waves files for 0 to 100 are created with the help of sound recorder and they are stored in storage card with naming convention- 0.wav, 1.wav up to 100.wav. Now 67.wav is searched and is executed by audio player.

(16) Implementation of Module 4 (Entertainment module) - This module is quite small and it is devoted to play a song number from Songs directory, there may be two cases arises-

Test case1- if song number exists in Songs directory then it is played by audio player

Test case2-if the song number does not exist in Songs directory, then an error message will be read aloud- "the song number does not exist".

IV. SmartRead Mobile TTS SDK 4.0

SmartRead Mobile TTS SDK[11][12] can run on Microsoft Mobile 2003/5.0/6.0, the ARM/MIPSII/X86 client of Pocket PC 2003/2003SE/5.0, translate the text to speech and transmit to speaker. It also can run on Windows Mobile CE.NET 4.2 system, but some changes must be done to adapt it.



Image 1: Image of the Smartphone with the application

TABLE 1
PERFORMANCE AGAINST SPEECH RATE

Speech Rate	Audio Quality
2	Too slow
5	Good
9	Too Fast to understand

V. CONCLUSIONS

This is very user-friendly Application for visually challenged person. I have successfully tested this software on windows mobile and it is working absolutely fine. The minimum memory requirement for installing this program into mobile phone is 5 MB and minimum processing power requirement is 100 MHz.

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