Voice-For-Blind: An Utilizable Email Client for Visually Impaired Users

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Indian Journal of Advances in
Science Engineering and Technology
Vol 1 No 2 2022: 53-70

IJASET

Original Article

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Abstract

For people who are sighted, visually impaired, or blind, electronic mail has evolved into a vital tool for collaboration and communication. However, the current email-related activities on smartphones cause a number of problems due to insufficient mapping of haptic feedback, complex text-entry layouts, a variety of screen sizes and orientations, illogical ordering of navigational items, and inconsistent interface design. The Components on touch-screen interfaces that can't be seen can be difficult for blind people to precisely access, making it difficult for them to carry out common mailing tasks such as receiving, sending, organising, managing spam, deleting, searching, and filtering. Due to these issues, blind people are having trouble using smartphones and completing a number of tasks related to email. Junk and Spam email frustration and cognitive overload are additional effects. We proposed Voice-For-Blind an utilizable email client that is friendly to visully imapired individuals to get around the obstacles relating to the usability and accessibility of smartphone-related mailing activities. 38 blind participants in an empirical study who carried out 14 email-related tasks are used to evaluate the proposed email client. The outcomes of this prototype's use demonstrate an elevated accuracy in complettion, improved user experience, and improved touchscreen interface control for basic tasks like email management. The findings show that Voice-For-Blind is an email client that is inclusive of accessibility, giving blind individuals an enhanced user - interface experience and reducing cognitive load when managing emails.

Keywords: **Voice-For-Blind, HCI, Email, Smartphones, Blind-friendly, Accessibility, Utilizability.**

1. Introduction

The blind people are an important resource in our society. Governments and welfare organisations are starting to take a more compassionate approach to the sharp rise in eye-related illnesses and the deterioration of vision. There are 285 million visually impaired people and blindness affects over 39 million individuals globally.as reported by the World Health Organization (WHO) [1, 2]. Assistive technologies are used by blind people to carry out a variety of daily tasks. ICT, assistive technologies, and assistive technologies based on mobile devices are some of these. In the past few years, smartphones have made significant advancements in the field of assistive and inclusive technologies for people with disabilities [4]. The touch screen devices, smartphones in specific, aim to make it easier and more independent for blind people to carry out daily tasks. Such smart-devices, however, vulnerable to a variety of problems with carrying out tass in a predetermined order, content organization, sequencing, and user interactions in general [2].

When using touchscreen interfaces, blind people operate in a predictable way. They typically steer clear of materials, interface functions, and pursuits that pose accessibility challenges to them [4]. The usefulness of touchscreen interfaces for blind users has been significantly improved by screen reading programmes and other accessibility services [5]. Even so, usability suffers when an interface is overloaded with non-visual elements on screen and numerous user interface components without any distinction or tactical cues [6].

Following audio commands in a loud and annoying setting, text-to-speech system feedback, and small keys are just a few of the usability problems that the multimodal interaction paradigm faces [7]. In addition, identifying componens that are not visible on the screen, organizing layouts arranged in a logical manner, and consistently placing tasks, icons, objects and visual metaphors are some of the problems faced by the blind, which frustrate users.

A new area of study is the usability of interfaces of applications of smartphones [8]. For both sighted and blind users, there are presently 2.2 million iOS and 2.8 million Android mobile mobile apps available [9]. However, due to insufficient accessibility assistance, for instance, inconsistent and ineffective interface design, the majority of the apps remained inaccessible to blind people.

The quantity and count of emails are constantly increasing because a sizable number of emails are exchanged every day [10]. The primary email activities are reading and responding, while the secondary email clent functions are utilizing and setting event reminders in calenders. According to studies, primary mailing-client tasks such as replying to emails, reading and writing take up a sizable chunk of time. Misusing email can lead to frustration, which not only wastes users’ time but also disencourage the user from working on their tasks [11]. The objecives of advocates for a common design is to make technology accessible to everyone [4]. People with special needs should be accommodated by technology in accordance with their needs, according to the ideas put forth by Riemer-Reiss and Wacker [12]. This can be done through a collaborative design process that includes evaluation for the purpose of promoting or adapting a particular assistive device. The absence of user interface features, direcional controlsand buttons is just one issue with the current touchscreen interfaces. Operating these devices and the applications that run on them is challenging because of these issues [13]. The creation of adaptive paradigm for the users for the design of user interfaces that are blind-friendly, accessible and easy to user has received significant attention from researchers [13].

It takes a significant amount of time and effort to organise email-related tasks like reading, writing, organising, etc. [14]. Similar issues still exist for blind people when it comes to email visibility and organizing emails into lables and folders [13]. In addition to these problems, spamming is a usability issue for those who are blind. Spam email poses a security risk because it can contain viruses, Trojan horses, and electronic worms [15]. Spam-filtering software, among other solutions for spamming, is one efficient method. However, these methods might not always produce positive outcomes [16]. For instance, it takes time and is dangerous for a visually imapired individual to browse through and hear email messages before finding the one they want. In these situations, a person might get a spam email, endangering his or her security and privacy.

This study introduces Voice-For-Blind, a functional email client that gives blind users more control over touch screens. The suggested solution in this article might assist blind people in arranging their activities or specific componenetsn in a particular order, making it easier for them to quickly remember placements, perception cues, and shortcuts for various mailing operaions. Each function and interaction has a state to indicate it, allowing for simple and efficient navigation between interface layouts. The state-transition diagram (STD), which depicts the sequence of operations and functions that go along with them, is how actions are expressed. 38 blind people who completed 14 tasks for evaluation of the Voice-For-Blind email client. The user experiences, task completion accuracy, and navigational loss were all improved, according to the results. Additionally, using a strong correlation, the Voice-For-Blind mailing system is evaluated at par with the other popular mailing systems lie Gmail and Thunderbird. Researchers and practitioners may find the research presented in this paper useful for enhancing touchscreen user interfaces for real-world problems faced by blind people.

2. Related Work

An understanding of efficiently using the items that are not visible on the touch-screen interfaces, navigation flow, content organization, user interacton, usuability and accessibility is provided by related work. The problems and difficulties that blind and visually impaired people face when using mobile applications to interact with touchscreen devices are highlighted. Usability and accessibility are both parts of universal usability. Although essential, accessibility alone does not guarantee universal usability [17].

However, there are a few factors that should be taken into account when designing interfaces. Numerous issues, including insufficient size of screen display, complex interaction paterns, and inconsistent UI designs affect how usable touchscreen interfaces are. Similar to web browsers, email clients also rely on a variety of usability factors, including screen designs, user interface elements, content organization, and workflow navigation. Accessibility-inclusive user interfaces are now necessary because of the emergence of user experience straeies in multimodal interaction paradigms.

An investigation into the viability of text-entry methods using speech-based methods on android and iPhone devices was presented by Azenkot and Lee [3]. They conducted a survey on a number of factors, including frequency, usage context, and the consequences of technology on individuals both with and without vision impairment. The findings show that Text entry using voice recognition outperformed text entry using touch by about five times, and that text editing and correction took up 80.3% of user time.

The researchers have provided illustrations of browsing suggestions [18], email systems [18], touchscreen artefact management [19], and the efficiency with which blind people can find a target on touchscreen interfaces [20]. A voice-operated email system for blind users based on Android has been proposed in the work presented in [18]. When entering plain text, they used a text-to-speech synthesiser to turn it into synthesised speech, predict intonation, and record their stress levels [18]. A mobile application for Android is available that contains the mail synchronisation agent for blind people, retrieves and synchronises emails from the database server. Similar to this, Shoba et al. [21] have presented a creative concept for creating a user-friendly email platform for those who are blind. They used a keyboard for input, an interactive keyboard, and a fingerprint authentication mechanism.

Common gestures like tapping and swiping can be used and are accessible depending on a variety of variables, including gesture recognition and characteristics like length, area, duration, speed and shape [22]. Romano et al. [23] performed a pilot experiment to ascertain the function of touch and motion gestures by blind persons when using cellphones for daily chores. The results demonstrate that a number of gesture actions are significantly influenced by elements such as mobile environment, backdrop and physicality of certain tasks. Buzzi et al. used an innovative method for tracking movements of touch interations from 36 individuals with visual impairments using mobile devices was described in [22].

They looked at how well gestures based on touch worked for visually impaired persons. The size and shape of the various gesture kinds was the key issue raised in this study. The use of usable motions when exploring touchscreen interfaces is also significantly influenced by the size of the touchscreen. The experiment's participants preferred single-stroke gestures with short, rounded shapes for executing a variety of tasks using interfaces that use touches. On a similar trend, the study of Macro et al. [23] looked at how motion and touch gestures are used are used by blind persons to carry out daily tasks on mobile devices. The simulator is tested on people with visual impairments and mobility issues. The system usability scale was used by Kortum et al. [24] to evaluate the utilizability of apps for tablets and smartphones. They gathered data from four experiments by having 3575 users rate the usability of ten frequently used applications. When the highest and lowest rated apps were compared, the typical usability score was 77.7%. They came to the conclusion that mobile applications are more usable on smartphones than on tablets.

Object and non-visual object positioning on touchscreen interfaces is a problem, according to Kane et al. 2008 [2]. For both sighted and blind people, the usefulness of using display edges, corners, and multi-touch operations, smartphone-based gestures are evaluated. Additionally, 129 blind people were polled by Wentz and Hochheiser [25] regarding the usability of email applications for carrying out various tasks on various email clients. They highlighted a number of difficulties with using desktop and web-based email applications for email-related tasks [26]. Additionally, they created an effective and practical email system for smartphones and desktop computers that allows users to send and receive audio messages in their mother tongue.

For people with communication disorders, an iterative interface called "Amail" has been proposed by Mahmud and Martens [27]. The ability of this email client to help those with aphasia manage their emails was its most encouraging feature. This design supports finding email addresses in the contacts list, text-to-speech conversation, and vocabulary customization. The framework has also minimised the steps needed to create a mail message. For visually impaired individuals to access the Internet and email, Shruti [28] postulated a framework for internet surfing. This application, however, was created as a research prototype and is not available for use by the general public or businesses. The text-to-speech voice message system was created by Unitha and Kalyani [29] and converts Telugu into voice. Similar to this, Wentz et al. [30] tested seven more popular mailing programs on 15 visually impaired participants. For their evaluation, they made use of Hotmail, Yahoo, Gmail, Tunderbird, Outloo Express and Outlook 2007l. Each email application has undergone evaluation by three to five blind individuals. Participants evaluated each application on 17 tasks and recorded the percentage of time it took to complete each task. The tasks included managing settings and folders as well as writing and reading emails and adding and deleting emails. According to the study's findings, Outlook Express was the top email program for blind people, scoring 91% out of 100% on all 17 tasks amongst tested email programs. Khan et al. [31] postulated, BlindSense, a global email interface protype that is accessible to people who are blind.

3. Issues and opportunities

The majority of research has previously been done on how to operate interfaces with a touch screen for blind users. Touchscreen user interfaces' emergence has created new possibilities that are accessible to people who are blind or visually impaired. The inadequate mapping of haptic feedback, learnability and discoverability, lack of logical organisation of navigational items and menus, user interface adaptation, search, layout, selection of non-visual items and the placement are just a few of the problems that blind people must deal with [4]. The following subsection discusses the problems and difficulties with touchscreen interface usability and accessibility.

3.1. Uilizbility Issues in Interface for blindusers

The development of the smartphones has significantly changed how people communicate. Blind people can use mobile assistance to read emails, schedule appointments, make phone calls, send and receive messages, and check their schedules. Through accessibility services like text-to-speech systems, blind people typically operate these applications and services. For visually impaired individuals to use a mobile device properly and read content on screens, screen readers are essential tools. These screen readers provide voice instructions to the user while reading an application's visual content or layout.

A blind person can benefit from these applications, but they also have to deal with inherited problems like noise and privacy. When recognising and adhering to a set of instructions for individuals with special needs in an outdoor setting, the noisy environment has a detrimental effect on speech recognition accuracy [32]. As an alternative means of interaction for the blind, Braille devices are available. However, there are many difficulties with Braille technology, including cost and literacy limitations. People who are blind avoid accessing questionable material [4]. Another source of frustration is having trouble downloading attachments [33].

3.2. Prospective Email Concerns for Visually Impaied Users

There are many accessibility and usability issues with the new ICT-based aids. The primary reason is that most Information and communication technology applications are made for normal users, which excludes blind people from the experience [34]. Additionally, a user interface's lack of compliance with accessibility standards affects how usable it is for blind users [35]. The following list outlines the usability issues for blind people managing and organising emails: Reading, organising, and managing a large volume of emails requires a significant amount of time and effort [14]. Similar issues that have not yet been investigated include email visibility approches, labels and managing emails in folders [11]. User preferences, device logging patterns, and usage context are used to adapt user interfaces. There is a significant need for revision of the user-centric user interface paradigm [4, 19].

3.3. Special Requirements of Visually Impaired People

The preferences of blind people must be taken into account in the creation of interfaces with access for all. The use of current email clients raises a number of issues. based on research into the usability of these email clients, we have noted a few limitations. We contend that these issues could be taken into account before creating a user interface that is accessible to blind people. They consist of the following:

- The blind should receive affordable, cost-efficient solutions. The currently available solutions are either expensive or have a cost per use. Furthermore, there is a licensing fee for commercially available assistive software.
- The absence of tactical and operational controls gradually reduces the usability of mobile applications.
- The development of an automatic speech-recognizer (ASR) is still in its infancy. Using ASR to run mobile applications in a noisy environment may have an impact on performance and accuracy.
- The semantics and syntax of the more than 8000 different languages spoken worldwide are varied. A small number of languages are covered by the current solutions. Each alphabet, set of features, phonetic system, and pronunciation are unique to that language. Applications and technologies therefore have a limited selection of features to adopt local and regional
- The need for cross-platform support arises from the fact that the exisitng mailing clients are created with a platform-specific technology. Due to these limitations, blind people are still not able to fully benefit from mobile technology.
- Visually impaired people proceed in a logical order, taking care not to stray from their path at any point.
- A streamlined interface should be created using simple instructions or command sequences to carry out a variety of tasks, and tasks.

Based on the flaws mentioned in the literature, we suggest Voice-For-Blind, a cross-platform mailing system that is usable to visually impaired individuals. We want to provide a simple email substitute that satisfies the usability and accessibility requirements of blind users.

4. Voice-For-Blind: An Utilizable Email client for Blindpeople

We set out to develop an email client that is usable by blind users in order to provide better user experience. This could help visually impaired indivduals remember a series of steps and make it simpler for them to understand concepts. The user interface design was able to maintain consistency in the navigational flow by making the command sequences for repetitive tasks memorable and easy to learn. Usability, accessibility-inclusiveness, and user interaction are the design pillars of the Voice-For-Blind email client [8, 34].

4.1. Framework for Voice-For-Blind Client

When assessing the usability of assistive technology, the field of HCI has developed a number of techniques, including simulations, modeelling, inspections and emperical study [36]. The requirements for interface usability and their adherence to accepted HCI models must be included in the design specification. Researchers, interface designers, and usability specialists frequently use the HCI models in the modelling interfaces for a variety of platforms, devices and users. Among these models are the user models, plaforms, presentations, dialouge, domain and the task. [37]. The model's overall perspective is depicted in Figure 1.

A hierarchical representation is provided by the task model of the operations carried out by blind users within an application. The series of interactions are described by the domain model as involving screen switching and state changes. The dialogue model explains the relationships between the different interface elements. While the presentation model lists the different computational components which make the interfacethe user model describes the characteristics of the user, including user modelling and user profiling, etc.

Consistency and perseverance are crucial for learning quickly and memory retention. Consistency is achieved by employing a state-transition diagram to portray each activity's state and the associated actions (STD). The three types of symbols used by the STD are node, arc, and function. A circle that represents a specific state of email activity is used to represent the node. The arrow connecting the activities, actions, and information flow is the focus of the arch. Arrows show how the state has changed.

Small squares demonstrate that activities have a common integer value. A transition-related action must be carried out each time a specific arc is traversed. The simple STD representation of the Tetra-Mail interface is displayed in Figs. 2, 3, 4, and 5. In its initial state, the system awaits the start of an interface activity by a blind user like closing, opening, or selection. The interface keeps track of each user's activity and the actions that go along with it. Fig. 6 shows how email activities are structured. The order of the tasks is created so that it can be quickly completed and is simple to remember. The favourite section will be filled with the user's most popular actions and activities based on their preferences and the application usage logs.

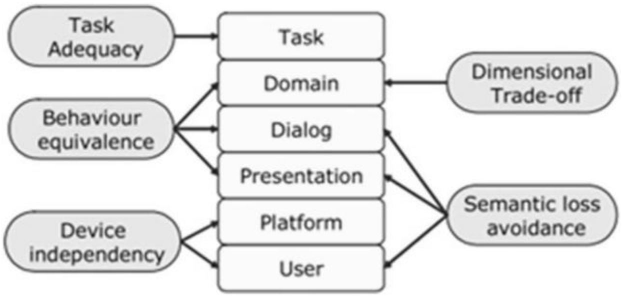

Figure – 1: The Role of User-interface Model in HCI

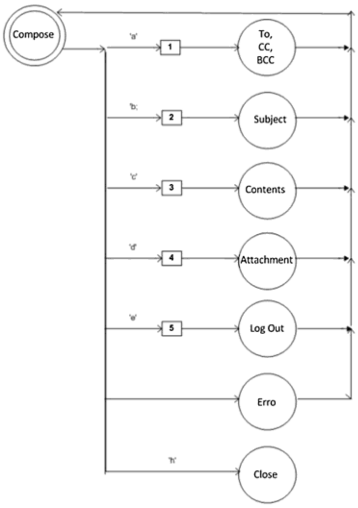

Figure – 2: Mail Composing Activity

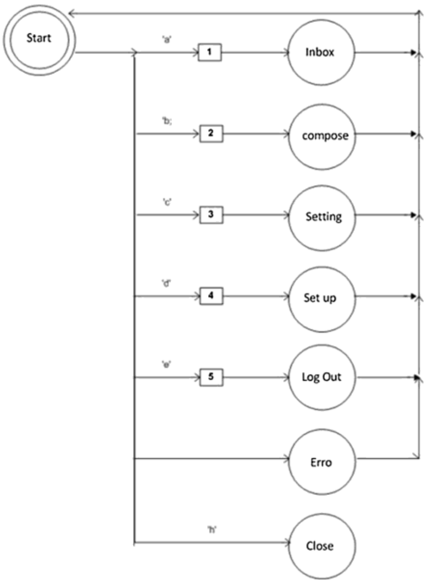

Figure – 3: State-transition Diagram for Voice-For-Blind

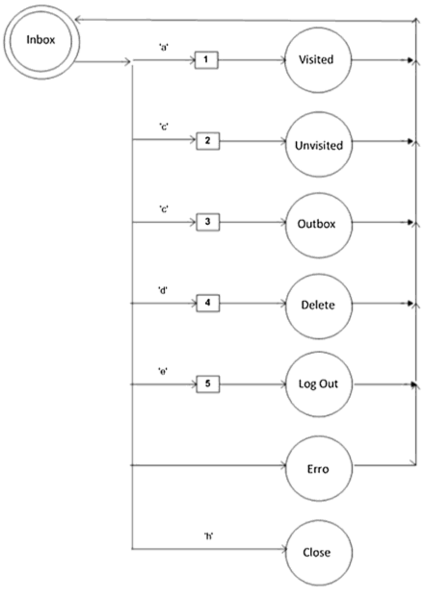

Figure – 4: Inbox Activity

4.2. Voice-For-Blind Architecture

Because of the layer-based design of this architecture, each sub-component interacts with the others seamlessly. The learning curve may get better with use as a result of the interface's design. Additionally, it might result in less memorization work in a shorter amount of time. The main factor used to assess the usability of the suggested solution is the level of understanding and semantic loss. By accommodating user activities and tasks in accordance, each interface screen is segmented into manageable groups. As shown in Fig. 7, the Voice-For-Blind architecture is made up of the following elements.

4.2.1. *The Interface Selection Startup Module*

Through the startup model, a visually impaired user had their first interaction with Voice-For-Blind. Touching the Voice-For-Blind an icon on a smartphone's display allows the user to interact with this screen. Five options—general settings, compose an email, set up email, and inbox—will be made available when a user taps a section of the email. As shown in Fig. 9a, Five shortcut features that are frequently used, including forward state, current state, previous state, andd home are located in the centre of the screen. The Go-back feature is activated by moving to the left with a finger, the Go-forward feature by moving to the right with the finger, the Go-home feature by moving to the top with the finger to the top, the Go-home feature by moving to the bottom with the finger, and the Sign-out feature from the active email account by long tapping the centre section. The various conditions of this module are illustrated by the STD in Figs. 3 and 8. Based on user input, the application is started in the start state, which can also start the inbox, compose, settings, setup, logout, and error states. In the event of a collapse, Error-State will automatically start up. Since the system stores all of these states, the user has the option of remembering the system's presentn state. A visually impaired user user can easily move forward and backward as well.

4.2.2. *Inbox Module*

Based on previous research into universal user interfaces, [4], this module's interface is split into equally manageable sections. The blind users will have access to four additional sub-components, including searching mail, outbox, unread email, and reading email. Once more, Whenever someone taps, the "read email" section, four additional operational options is lised: up/down scrolling, reading, deletion, and listing. The contents of the email will be read aloud using the text-to-speech system. The user can then choose from additional options eitherr reply to all or reply email, delete mail or forward email. In this scenario, the recipient ID will be entered using the keypad and the same procedure will be used to tap into the section for unread emails as well. Similarly, whenever the user taps the "Search Email" section, the control moves to the keypad, and the emails that were found during the search are shown. Email reading can be controlled by the user's up-and-down scrolling. Fig. 10 shows the STD of this operation, while Fig. 9b shows the application interface.

4.2.3. *Email Composer Modulel*

Four sub-components make up the email composer module.: creating a new email, attaching files, setting the subject and contents, and adding a TO, CC, and BCC section. Whenever an individual user touches this area, the screen will read in the order: TO, CC, and BCC respctively. The compose email section's sub-components will take over at that point. Once all of these steps have been completed, a continous tap on the centre area will send the email. Figs. 9c and 11 present the STD and application interface, respectively.

4.2.4. *Management Module*

The management module consists of four components, including email accounts, contacts, folders, and signature management. The first component is folder management, which has four sub-components: creating new folders, erasing existing folders, renaming folders, and moving folders. The control is transferred to the keypad whenever a user touches the new folder, and a process cycle is finished after the user enters the folder's name. Similar to this, whenever a user touches the Delete Folder option, a list of every folder is displayed. By pressing long touch on each folder, a folder is correspondingly deleted. The option to list folders will appear whenever a user touches renaming a folder, and the user will need to press the long touch to shift keypad control and finish the renaming process. Similar results will be obtained if a user selects the delete contact option. A long tap on the desired email address will activate the deletion option. The contact(s) can be found by typing text into the keypad, which will return a list of contacts. Figures 12 and 13 shows, respectively, the STD activity and application screenshots for the aforementioned functions.

4.2.5. Feedback Module

The user interfaces for this email client have been created so that blind users can effectively send and receive emails with the fewest number of operations possible. The voice interaction and touch-based responses for checking emails and speaking back emails both incorporate a variety of haptic responses. In the overall design, the process of going back to "Home" is consistently available, allowing blind people to go back to the beginning in the event that they get lost in a complex content listings or menu structures. Similar to moving forward and backward, voice interfaces are also used for navigation. For typical navigational tasks like Back, Home, Next, Up and Down, and so forth, specific patterns have been created. These commands, which are correctly linked to temporal parameters, are used by the application to control content..

From the application's configuration option, these settings can be changed. The voice UP command is used to scroll, which reads out the entire screen's content. The application offers a unique, prolonged vibration that simulates the screen's edge.

The user then issues a navigation command for up or down. Although it depends on the user's preferences, there are choices for nonstop reading in the configuration settings. The scrolling page options have a very high stability and ease because they are particularly rooted on the finger model and placement and use habits of blind users.

5. Results and Evaluation

The study's main goal was always to develop a blueprint and design for an email client for blind people that works well on smartphones. The suggested solution might make it easier for visually impaired users to manage, organize, receive and send emails. Through the use of standardised Usability and accessibility standards for HCI, the design's usability has been assessed. We assessed how well each task was completed on time, how accurate it was, how easy it was to complete, how much semantic loss was experienced, and how many other email-related tasks were completed. We contrasted our suggested solution with other email clients, like Thunderbird and Gmail. As a result of its consistent and accessible interface design, Voice-For-Blind is demonstrated to be a better option for blind users.

5.1. Materials and Methods

To test the prototype Voice-For-Blind implementation, 38 participants were randomly chosen from various institutions and universities in Pakistan and Afghanistan. The participants' experiences using smartphones varied. A few of them had over six months, while others had around a year. The majority of participants were college students and staff members from various organisations. Table 1 lists the participants' information.

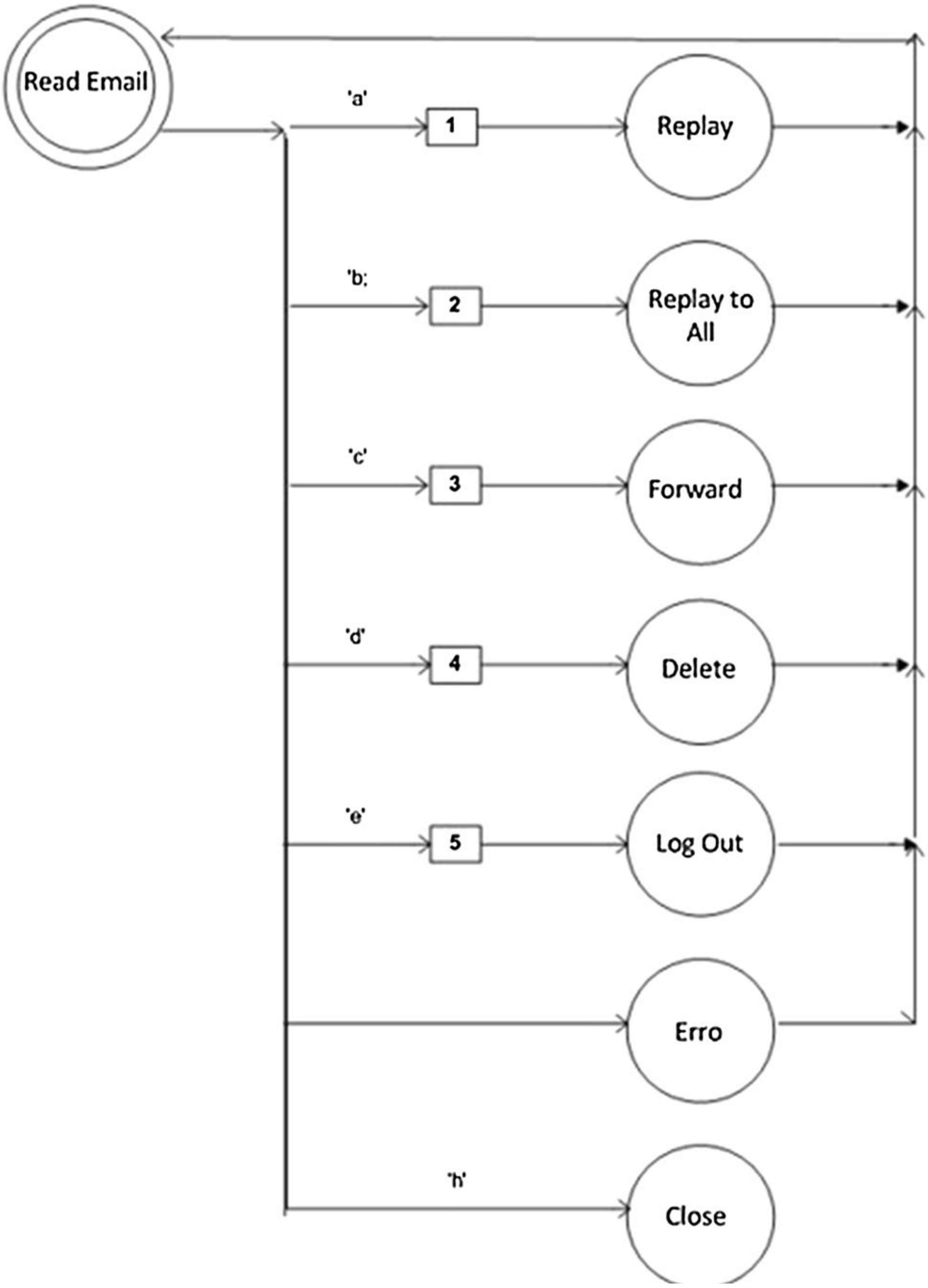

Figure – 5: Read Email Activity

Everyone who participated in the study received the same kind of pre-established tasks because it was carried out individually. The study was divided into two parts: in-wild response collection (through keystrokes) and observation, interviews and semi-structured questionnaires. 14 fixed tasks were assigned to selected participan. 1696 keystrokes in total, including incorrect and missed presses, were recorded. The tasks were divided up into various groups. Each participant was subjected to an exercise that lasted, on average, 66 minutes. To confirm the degree of comprehension and usability, two researchers actively participated in watching task execution. Participants' smartphones included the iPhone 5, Qmobile A12 and Samsung S6.

5.2. Evaluation Criteria

The captured responses and keystroke data were gathered with the following categories: (1) missed touches, (2) incorrect touches and (3) Total amount of keystrokes. An integrated stopwatch is used to determine how long each activity lasts.

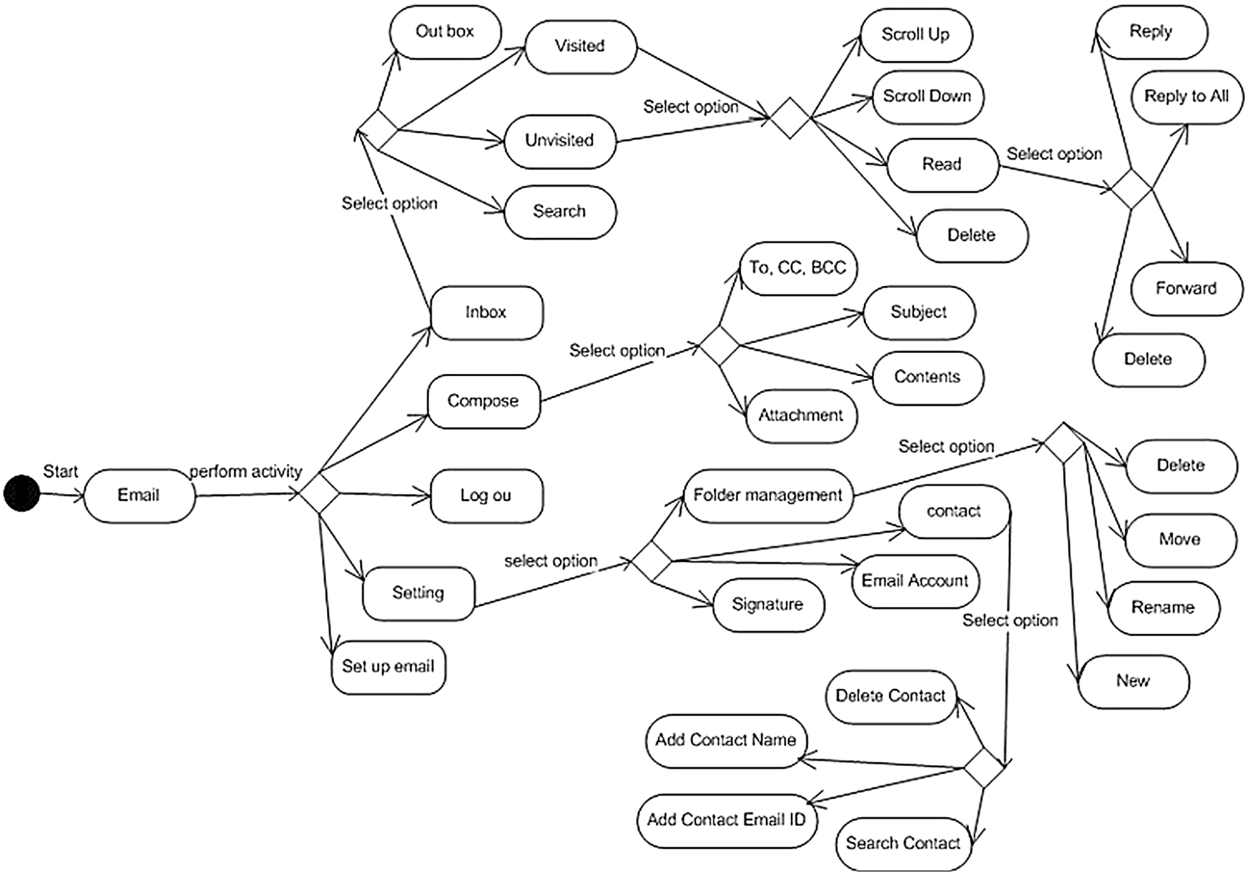

Figure – 6: Structure of Voice-For-Blind Activities and Actions

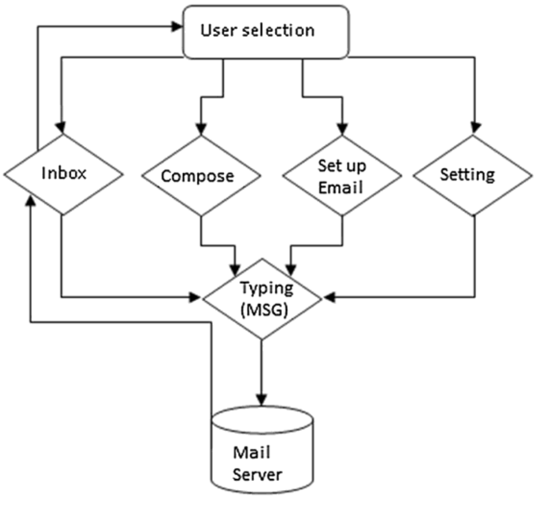

Figure – 7: High-level Architecture of Voice-For-Blind

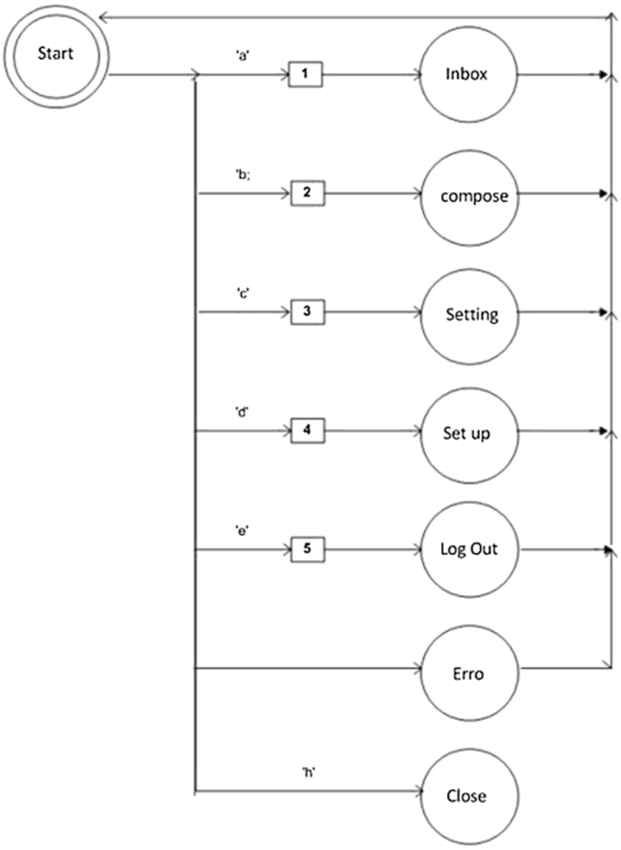

Figure – 8: Startup Module

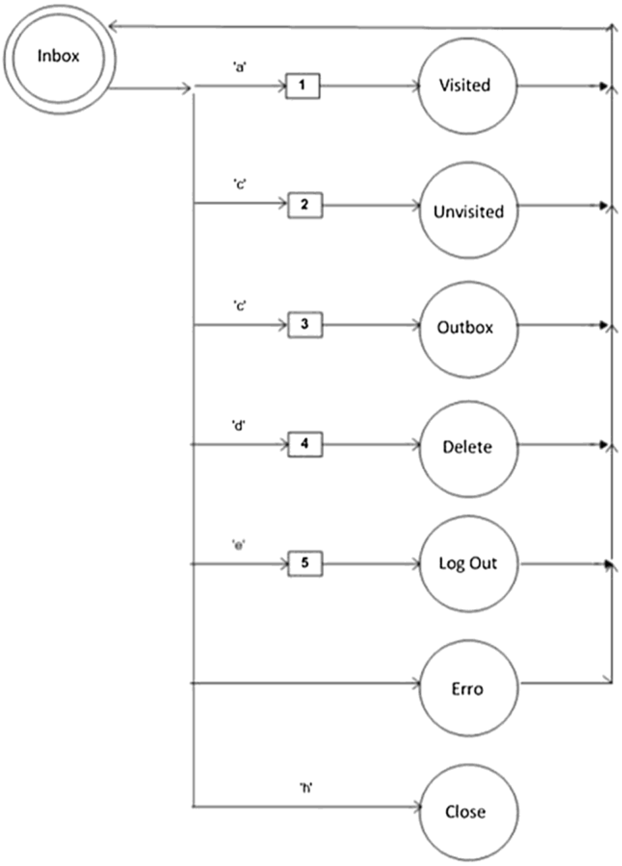

Figure – 10: Inbox

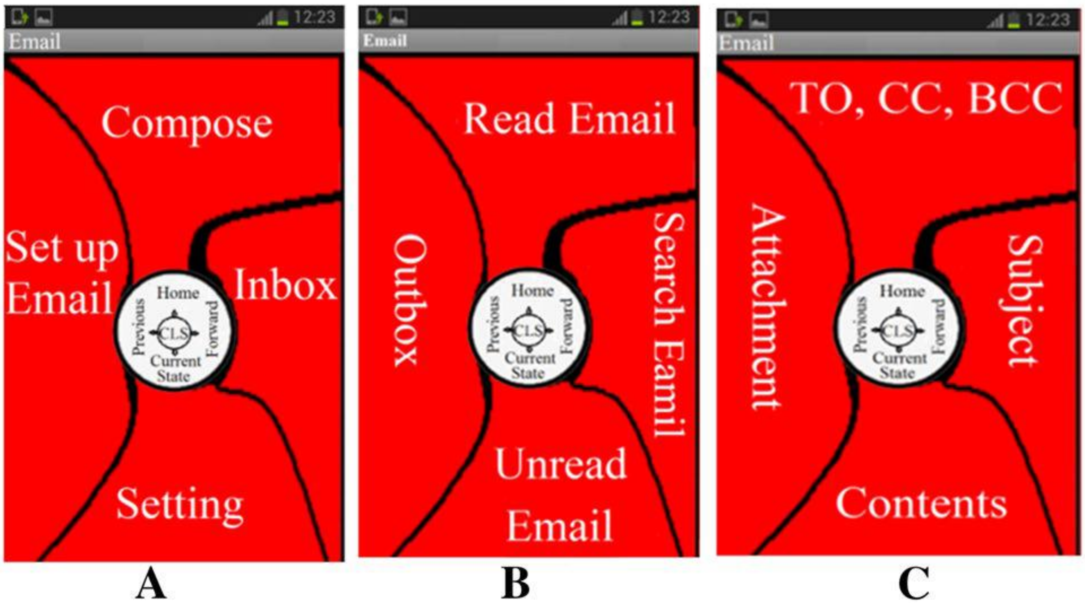

Figure – 9: A) Application B) Inbox. C) Inbox Screen

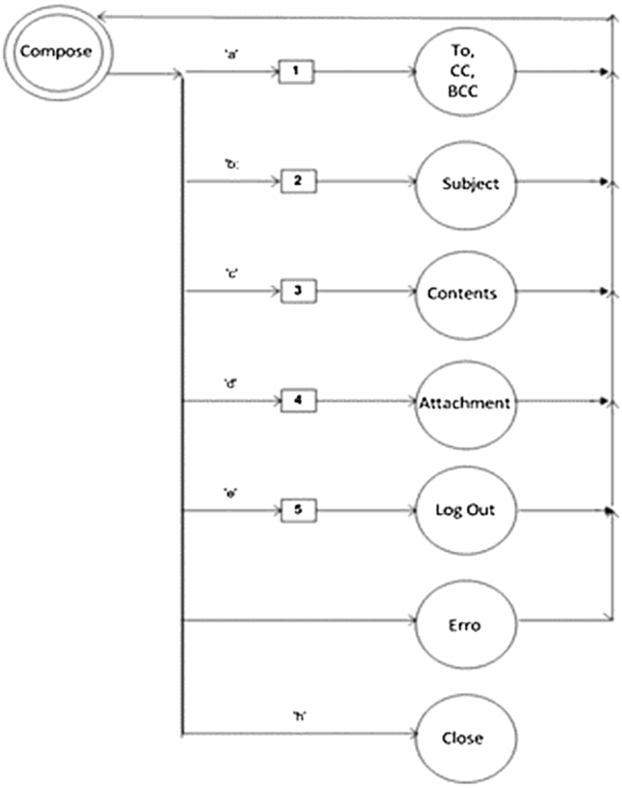

Figure – 11: Compose Email

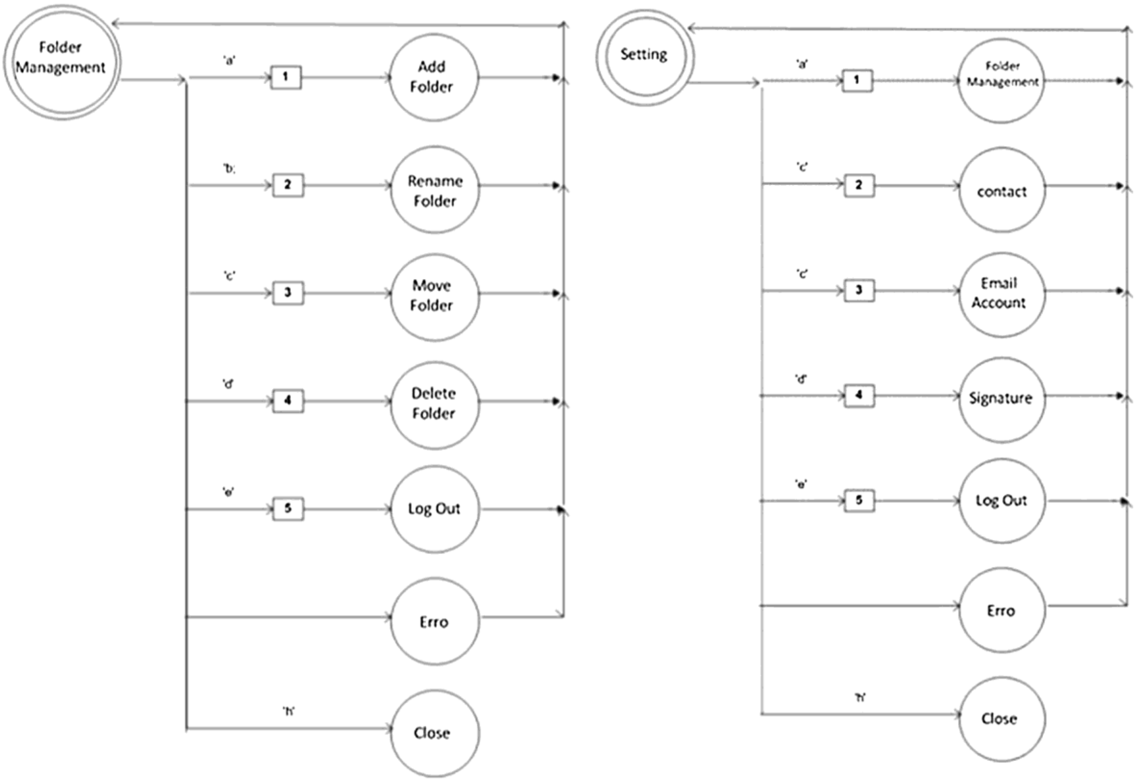

Figure – 12: Folder Management

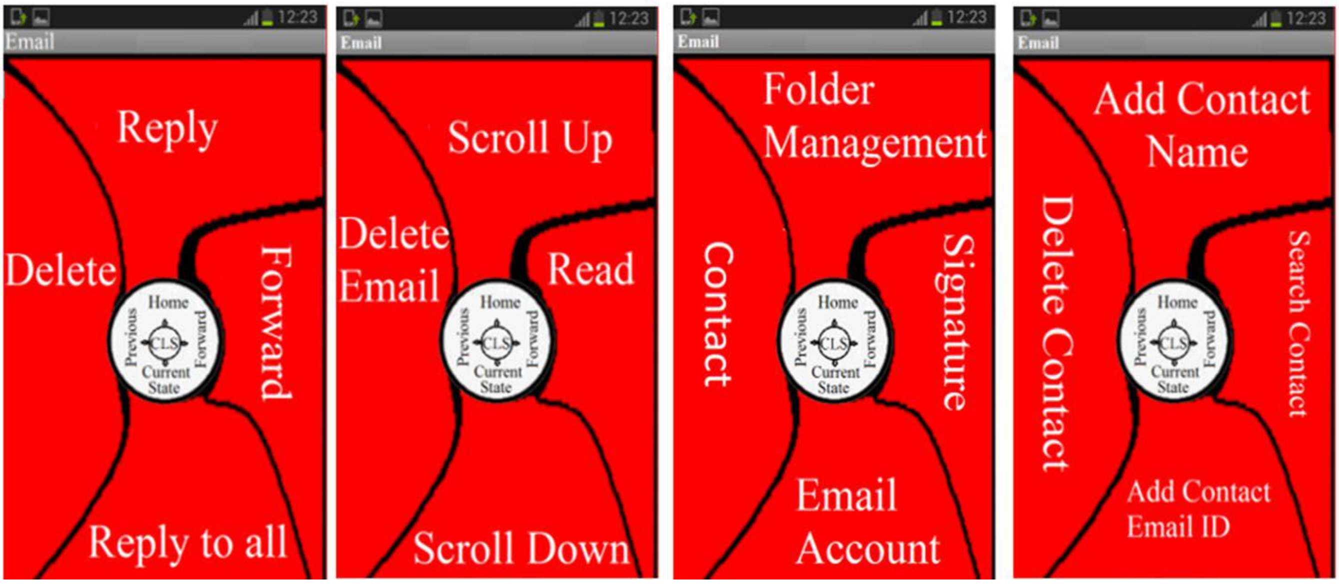

Figure – 13: Folder Management and Inbox

Keystroke-Level Model (KLM) [37] has been used to identify processes and assign unique timestamp for each. Through KLM, the activities are monitored. The task-execution time is then calculated by adding these timestamp values to the total time term. The responses obtained from the questionnaire and interviews were validated using the KLM. Using a set of reference assignments, we have determined the accuracy and simplicity of each task. We allowed the blind participants to use the email client for the first time before asking them to prepare for the evaluation. Only the observation study utilized a "think-aloud" spoken guideline for the benchmark tasks. During the observation phase of the study, the think-aloud mechanism was employed to determine whether or not the reference assignments met the necessary level of agreement. As a result, they expressed their opinions about the activity verbally. The survey administrators watched how they interacted and verbally verified what they had seen.

We calculated the task completion times, accuracy, and usability while completing a number of tasks, and used those results to determine the values of these parameters. The time needed to complete a specific task within an email interface is identified and calculated using the keystroke-level analysis. The total amount of time required for every proceesses, as shown in Eq. 1, where Tk is keystroke time, H is homing, M is mental preparation, and R is system response operator, and whcich can be used to estimate the task-execution time:

$$Tk = Tk + Th + Tm + Tr \qquad \ldots (1)$$

The blind users chose the following criteria for the evaluation of the email applications:

- *Duration of task:* It is the length of time needed to finish a task or procedure. Two additional sub-parameters, namely the percentage of the task completed and the amount of time spent on completing a specific task, are included in the time needed for task completion;
- *Accuracy of task:* Through keystroke analysis and observation, this parameter was used to assess task completion accuracy;
- *Difficluty of task:* The usability of task completion was measured to assess the proposed interface's usability. The user-friendliness of the interface can be evaluated by counting the number of times users switch between different interfaces. This parameter's measurement is subjective and correlated with other parameters like timing, precision, and semantic loss;

- *Semantic loss:* To prevent confusion while a task is being completed, the interface's structure shouldn't be overly complex. The user should be aware of his or her current state, upcoming activities, and previous actions with clarity.

We used Eqs. 2, 3, and 4 to quantify the level of semantic loss in an interface, where M stands for mean task completion, A for accuracy in task execution, E for ease of task finishing, and SL for loss of semantic:

$$T = A + E + SL \qquad \ldots(2)$$

$$\text{Mean} = T / 3 \qquad \ldots(3)$$

$$SL = 100 - \text{Mean} \qquad \ldots(4)$$

Semantic loss will be zero percent if a task is fully completed 100% ease of use and accuracy.

Variable	Group	Number	Percentage (%)
Gender	Female	09	23.68
	Male	29	76.32
Country	Pakistan	21	55.26
	Afghanistan	17	44.73
Age	21–30 years	31	81.57
	31–45 years	7	18.42
Background	Educated	116	84.67
	Literate	21	15.32
Smartphone Usage xperience	No experience	4	10.52
	6 Months	13	34.21
	12 Months	21	55.26

Table 1: Participant information

5.3. Results

In three iterations, we recorded 532 responses from 38 participants who completed 14 tasks, for the total number of 1596 captures of which 1501 were found to be accurate and 189 were invalid. In the end, not every iteration was used. We went over each capture and iteration, marking the responses that could be used in further analysis. Voice-For-Blind, Thunderbird, and Gmail's usability parameters were all statistically evaluated in-depth for all three email clients. The statistically significant differences in the results were measured using an ANOVA. The findings demonstrate that there are substantial distinctions. P values fall below Alpha (α) and in a similar manner, Typically, the determined F values are greater than the F-crit values., causing to believe that, for the most part, the sample of population are not equal. Similar to this, most of the times the determined F values are significantly greater than the F-crit values, leading us to believe that perhaps the population means are not equal. If the F value is below the F-criteria and the P - values for semantic failure is higher than 0.05, The null hypothesis can be rejected, and we can conclude that the means are comparable. Voice-For-Blind, however, had a very low variation (variance σ2), which is unmistakably evidence that Voice-For-Blind is better compared to all other email services on the market.

6. Discussion

14 exercises have been considered from a survey that Wentz and Lazar [30] conducted. They were used to evaluate the Voice-For-Blind email client on its usability and accessibility in terms of its four key components. The majority of the 14 tasks were first completed, but some remained unfinished because of challenging workflows such as adding attachments. Second, the time duration is used to estimate the accuracy of the tasks completed (in seconds). The ratio of accuracy in completing tasks is the third factor. When performing an activity, standard deviation is represented in this analysis. The highest accuracy value was 100% whereas the lowest was 84%. The task that was rated 100% easy by the participants as being the easiest was deleting an email. Moving a folder was rated as a challenging task with a score of 78%. The complicated workflow process it required to complete was the primary cause of the difficulty. The final parameter is the semantic loss; it is crucial to comprehend the interface's complexity as well as to accurately

capture user behaviour when engaging in a process. The app has already offered flexibility in the form of a feature that allows blind users to always be aware of their current situation. By calculating the accuracy and ease values, we were able to determine the semantic loss parameter and determine whether the task is hard or easy.

7. Conclusion

The mainstream mailing clients— also referred to as email applications—that are currently available are made for regular users and certainly they do not specifically cater to the needs of visually impaired individuals. Since most smartphones lack physical buttons to mark the positions and locations of the screen's intangible objects, blind people must locate links, options, and buttons by scanning the entire screen. Due to this, using an email can be difficult for people who are blind. Blind users can memorise the flow of activities thanks to the consistent screen division, which lowers the risk of getting lost among the screen's other options. We assessed the effectiveness and usability of our suggested solution by contrasting it with currently available email clients and applications, such as Gmail and Thunderbird on mobile devices. Our initial findings show that the present remedy is superior to other ones because it organises initiatives and pursuits consistently, reduces subjective load, and enhances tactile reactions.

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