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Smartphones' Calling Application Usability Improvement for People with Special Needs

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ABSTRACT

When it comes to the implementation of the concept of ATAWADAC (Any Time, Any Where, Any Device, Any Content) smartphones play a primary role. Smartphones are owned by more than 45% of the world's population. Therefore, the capacity of smartphone applications to be used in a simple, effective, and efficient way is fundamental, especially for individuals with special needs; knowing that 15% of the population worldwide live with at least one form of disability. Most of the people with special needs and novice users use smartphones to make/receive calls, send/receive SMS. In this paper, a UI for smartphone calling applications is proposed, and algorithms are developed to minimize the cognitive biases, motor, and visionary problems, with the main goal to improve the calling applications usability and to enhance user experience. A comparison of the proposed design and other applications is provided.

Key words: Smartphone layout, calling, receiving, adaptation, usability.

1. INTRODUCTION

The mobile platform is becoming ubiquitous among senior citizens, the functionality of this platform is increasing to serve various purposes, together with entertainment, m-learning, social networking, and m-health [1]. New technology is introducing and implementing to improve the information and communication for everyone, including people with special needs [2]. Special needs is the language used in clinical investigative and functional progress to describe individuals who need assistance for disabilities that may be medical, mental, or psychological [3]. Moreover, older people having a problem with physical, cognitive, and sensory capability, which causes limited physical mobility [4]. The limitation of physical mobility referred to as difficulties to move, going up or downstairs, and other seven types of health problems among older people of both sexes which requires association with several types of functional dependence [4]. People who are not literate and has a basic knowledge of operating smartphone called the novice user [5].

The smartphone is a common term used to categorize mobile phones, it has an independent operating system, touch screen facilities to interact with, allow users to install any third-party applications like games, social networking, etc. [6]. Mobility is defined as the capability to travel by any type of transport including walking, cycling, vehicles, or airplane. Moreover, mobility enables access to communicate with each other from anywhere and time [7]. The wearable technology creates another trend in society, which introduced inactivity alerts [8].

People with special needs having mobility and motor problems [6], they require technological devices in their daily activities to carry out banking transactions, social networking, reminders, phone calls, planning, messaging, e-mails, video calls, etc. [9]. The cell phone was developed just to make calls and messaging purposes, but now due to the development of smartphone with its technology, meeting most of the modern technology which has advanced functionality to serve all general needs, allow users to perform different activities and the task at a certain time simultaneously [10]. For instance, a smartphone is a portable computer, allow users to make video and voice calls, messaging, trace the place where the user is now with global positioning (GPS) [10]. Many third-party applications are very popular like Facebook, WhatsApp, QQ, WeChat, Skype for video, audio, and text messaging [11]. Smartphone operating system provides traditional short message services (SMS), Operator based voice calling system [12].

Officially 5 billion people are using mobile operator services globally [13]. At present population, aged 65 years is around 1 billion and by 2050 the population expected to be 2 billion [7], [9], [11], [14-16]. The smartphone application user interface (UI) is generic for all kinds of users. The mobile manufacturing industry developing layout interfaces according to the trend of the time to commercialized their products [6], [17]. People with special needs and novice users use any type of application in their smartphone like mobile operator voice call, note-taking software, social networking, staying in contact with the family members and friends by live video streaming, telemedicine, etc. [18]. All the application run time, users need to interact with, to execute the functionality. The special needs and novice users do not like to use smartphones because of usability, short term memory,

motor problem, and technology adaptation terror [19-22]. To make calls, special needs, and novice users sometimes call the worn person, could not find the navigation button to hang the phone, occasionally press the end call button instead of call receive button. While phone ringing and the user is busy, special needs and novice users failed to send SMS by hanging the phone. Moreover, the smartphone cannot do automatic redial or send SMS to anyone.

The smartphone is designed for regular users and UI of the smartphone is not optimized for the special needs and novice users [6], [23]. Most of the special needs and novice users experience visual acuity, presbyopia, failed to recognize the color contrast, small text, and icons; declined acknowledgment of text input box, and buttons because of the visual appearance [18].

After realizing all these issues proposed a smartphone calling application, which considers the special needs and novice user's color contrast, motor speed, and visual acuity capabilities. This paper is structured as follows. In section 2 describe details about the usability and user experience of special needs and novice users. Section 3 discusses the special needs and novice user problems and experts' opinions. Section 4 all about the proposed solution. Section 5 shows the comparisons and algorithm complexity. Finally, conclude the paper with the future direction in section 6.

2. BACKGROUND

2.1 Usability

Usability is the capability of things which we used to our standard of living, it makes complex things simple to use and develop them according to the user's demand [24]. Another way can say usability is associated with user satisfaction and how efficient and effective he/she can perform the job with the UI [25]. Efficiency refers to how faster the user can finish the task [26], effectiveness denotes improve the usefulness of the system [17]. Usability is the core work of Human-computer interaction (HCI). A usable product must have three qualities, (1) The product is calm for users to become familiar with and capable in using it at the first interaction, (2) the functionality is easy for the users to retrieve their objective by using it, (3) the functionality is easy for the users to recall by the users while using it at second visit [26].

2.2 Age-Related Changes

Aging is a natural process that typically comes with physical and cognitive changes [19]. Physical changes refer to the effect on visual, motor, and hearing capabilities. And cognitive changes denote memory loss and learnability capabilities.

2.3 Visual Capabilities

Visual problems are observed to any person around the age of 40. The cause of visual impairment is age-related muscular degeneration [27]. The visual capabilities get affected by a person because of aging. The most substantial changes experienced in the visual acuity, presbyopia, peripheral vision, and dark adaptation [18], [19]. UI with small text, light color, small button creates visual discomfort to the users [20], [28] and some users failed to recognize the color contrast of the applications [18].

2.4 Motor Capabilities

Motor capabilities state as when users face a difficult time to find the targets and make less exact movements [18]. Another way can say age-related changes at hand function decreases at strength, dexterity, and range [12], [29]. Special needs and novice users are inhibited to interact with mobile touch screens, they need time to interact with the application [18]. Research shows that special needs and novice users required more 50-100% time to complete a task than normal users [14], [23], [27]. Users required fine motor speed to run smartphones because they need to scroll, do single, and multiple taps [26], [30].

2.5 Hearing Capabilities

Hearing loss is a common problem for the special needs of 50% of men and 30% of women, most of them face problems with social interaction [18], [27], [29]. The special needs some times tend to downplay or disagree with any hearing loss they might have [18]. The weak ear cannot detect very high and low pitches, this is one of the main reasons these types of mobile users failed to feel the phone ringing and other notifications [14].

2.6 Cognitive Complexity

The mobile application requires a confident level of procedural knowledge. The long-term memory stores the interaction procedures to do the task in any situation, the usability of the application helps the users to complete the tasks properly. When the user cannot store the information in the memory properly and the result, they failed to complete a certain task [16], [19], [27], [31-33]. The suitable visual design of UI is not sufficient for special needs and novice users, the information architecture, wording, and icons need to be implemented in an organized way, if not then the user gets confused and tend to blame themselves instead of the application [14]. When users try to interact with a UI contains a very large amount of text and buttons, which might originate distress to the users [18].

2.7 Learnability

The learnability refers to learning by a smartphone that is integrated with the existing system to support real-time communication and deliver information [34] and learnability can be measured by time to learn a task [26]. Application guidelines always suggest to enlarge the interface elements and the interactivity should be focused on learnability and memorability [19]. Learnability is a factor for the special needs and novice users if they face problem to communicate

with the application then failed to give the deliverables from the application.

2.8 Mobile Interface

The smartphone starts from a 4-inch large display or bigger. The mobile interface and inputs are controlled by finger touches, swipes, and other gestures [14]. The smartphone comes with the home screen, dialer, SMS, contacts, and many widgets and a complex interface (small icons, compact text size) which contains all the information of the world for kids to seniors [20], [35]. Each branded mobile has its own designed interface and some interfaces are designed only for specific countries and tribes.

2.9 Accessibility on Touchscreen Phones

Accessibility is defined as the quality of access, whether it is related to the social or technological environment [13]. Another way can say the usability of a product, service, environment, or facility by people with the widest range of capabilities [13]. Accessibility is not a single object or issue, W3C and WGD provide a guideline to accomplished the accessibility [26], the guideline emerged with (a) text readability, (b) simple layout structure, (c) sharp contrast between background and font color, (d) information accessibility, (e) Minimized text input, (f) continuous assistance [16].

2.10 Interactive and interface design

Interface design contains interactive design and graphic design. Interactive design focus on the interaction and user behavior of how they interact [36]. HCI designers always consider that every human on this earth is unique and fortified with different abilities and different cultural background [18]. The interface design of an application often hinders the adaptation of technology for example, one user uses the application with perfect efficiency and another user with motor difficulties finds the application very awkward [18]. User interface design for special needs and novice users should be easy to navigate and simple, with no complex gestures, double taps, and long-press [14]. The interactive design principles followed by (a) friendly, (b) flexibility, (c) functionality, (d) clearness, (e) consistency, (f) reliability, (g) graphical [36].

2.11 Navigation

Navigation refers to the menu of an application or navigating from one page to another [37]. The navigation should be consistent and straightforward. Thus, at the front-page layout design, a button that navigates to the next page is set at the bottom right side of the page, and the other pages navigation button should be at the same place [22], [37].

2.11.1 Menu-oriented Navigation

Most of the applications use menu-oriented navigation moreover, menu navigation is a very common practice in all platforms [26],[30]. Menu navigation provides access to additional contents like loading another page, move to another section from the present section [26]. experts suggest developing a flat menu structure instead of a multilayer structure because users get confused where they have to go and where he is now [30].

2.11.2 Content-oriented Navigation

The content itself provides navigation and hierarchy to inform users about the other pages of the application [30]. The smartphone enables more versatility in interface designing, an icon of an image or a button can be used for navigation instead of the menu [26]. Users like to use the linear model of navigation instead of structural navigation in the mobile application [30].

2.12 Proximity Sensor

A proximity sensor is a semiconductor hardware device which has 160 GHz radar monolithic microwave integrated circuit with two flexible dielectric waveguide transition, this device can detect human organ from 300mm distance [38]. This device is installed on all smartphones. This device used to turn off the mobile screen after received the call and put the phone near to the ear.

3.UNDERSTANDING THE ISSUES AND COLLECTING REQUIREMENTS

Research shows that people with special needs have significant differences in their actions and behavior. There are three types of older people in society [31].

Fit Older People – This group of people do not consider themselves as special needs but functionalities or support they need are different from those they had when they were younger [31].
Frail Older People – This group of people are considered special needs because they have severe disabilities and have weakness in their other functionalities [31].
Disabled Person Who Grow Older – This group of people have long term disabilities get affected by the aging, the functionalities are critically dependents on others [31].

The proposed solution focus on frail older people and disabled person who grow older. When special needs and novice users use the smartphone, they face different issues while using the device. Below describe details of these issues.

3.1 User Friendly

User friendly refers to the system easy to use and the better accessibility of the system [36]. Special needs and novice users think that the smartphone is no use to them because they just need to receive incoming and outgoing calls and text messages, these three basic functions can be done by featured phones better not to waste their money [10]. When special needs and novice users use an application, runtime they need to drag and drop an object from the application to give input which creates a biased environment for them [36].

3.2 Flexibility

Mobile application flexibility refers to the system that can use multiple ways to interact to complete a specific goal [36]. There are certain cases special needs and novice users need to give multiple trials of input to do one task simultaneously, suppose a user is calling a person and the line is busy, user need to call again and each calling user need to select the person from the dialer-list and call, which is a redundant process.

3.3 Clearness

The clearness means that no matter how complicated the system its self, the user understands the system and user memory has a clear, consistent model of understanding the system and predict the behavior of the system at any time [36]. Special needs and novice users facing many problems regarding the clearness. When the user serf internet through the browser, the page is long and the user "single tap" the page right side and the scroller get visible in the browser, if "single tap" not registered, then the scroller would not be visible. Most of the time this type of issue puts the users in a biased position [25], [26]. Book reading application some are supportive with "double tap" zoom in and out option and same time some applications have different functionality to zoom in [16]. There is some calling application when the user receives a phone call need to "hold and drag" or "swipe the fingertip" a button to the screen for answering and same time other calling application works on "single tap" a button for answering, "hold and drag" or "swipe" motion gestures are not suitable for these type of users [11]. Experts suggest that the call receiving application a "single tap" action to register an answer button is the solution with less human error [11].

3.4 Screen brightness

Visual acuity, peripheral vision, and dark (background brightness) adaptation types of vision-related syndrome faced by special needs [18]. These issues need to be overcome by following certain rules like the brightness of the mobile screen would be consistent [11], [18], mobile screen at outdoor environment brightness level should be 20% higher than the indoor environment [39], [40], the application background color should not be pure white and brightness should not be changed at application level one screen to another, must be constant to all pages and also the object's color in the application should be dark [39], [41]. The application should have different color schemes for the users, so they can choose a suitable scheme which is suitable for their eyes [21].

3.5 Consistency

The consistency refers to the system which is consistent, the system follows the discrete manner at each step and community way of thinking [36]. Consistency is essential for learning and cognitive act [27], [42]. A consistent interaction designed system would help users with their knowledge and experience to promote the use of the new system, orders, and operations to run, therefore it would lessen the user's new learning and memory load [36]. Special needs and novice user face problem while they use an application which back button exist the at top of the main page, while the user navigates and visit other pages found the back button exist at the bottom of the page moreover, some application do not have the back button at all [11], [25], [33]. There are two types of menu named single and multi-structure. An application contains both two types of menu, one page of the application contains single structure menu and another page contains a multi-structure menu which makes the system inconsistent to the users [5], [13], [28], [29], [39], [40], [43],[44]. There is some very long menu and user require to scrolling the menu to check the topic, this action is a violation of consistency [5], [21], [26], [30], [31], [36]. Moreover, applications use a single structured menu but same application different page uses different color menu, as a result, creates confusion to the users [39].

3.6 Graphical

Smartphone UI depends on the graphic design moreover, button, menu, icon, and navigation is part of it [2], [20], [22], [45]. Expert suggests that the interface should be simple and no animation should use, the icon should be simple in color and meaningful [41]. The UI design time, a maximum of five types of color should be used [33], [39], all the contents should be developed with text, image, and icons [31],font size is very important in the content development, for the special needs and novice users face problem to read the small size text because of background noise, moving object, hand is not stable (shakes), the font size should be between 36pt to 48pt [6], [11], [13], [14], [16], [18], [21], [25], [26], [28], [41], [43], [46], [47], [48]. The font color should be always dark and background color should be a very light color, the text should be left-aligned and same font family (sans serif, helvetica, arial); avoid fancy type format italic, underline, stroke and all caps in the fonts [12], [16], [19],[23], [31], [39]. The heading of any content should be more than 48pt and the border with weight [14]. The objects like button, list box, select box background and text color should be very dark, some designers used green and blue background and text color in the button, as a result, the special needs and novice users could not read the context of the object. Experts suggests that object background color should be mild green and blue, and text color must be white or grey [12], [14], [26], [32], [39], [43].

An icon transforms the information quickly and accurately, it plays an important role to transform information, express the link between the item and its meaning which it stands for [2], [21], [39], [41], [46]. Icons are used in the application to shorten the texts; symbolic images are used as an icon to express meaning [18]. Most of the applications, icons are too small and used multiple times to represent different meanings [45], moreover special needs and novice users mixed up the icon with other objects on the page and made mistake at interaction time with the application [16], [42]. Icons should be colorful, meaningful, combined with text and graphics for beautification [33], [39]. The icon should express the meaning

clearly and the text label used to clarify the meaning to avoid the human error [11], [19], [20], [30], [31], [40], moreover, icon design must be clean and color contrast must be combined with background, icons size should be bigger than 8mm, cannot add more than five colors to design an icon, recommend gray color because is plain and creates simple visual effect [14], [22], [36], [39],[48],[49].

3.7 Tapping

Smartphone users interact with mobile devices to run an application by scrolling, input data, select menu, and press buttons. While the special needs and novice users select a text input box or menu or a button to press, most of them made mistake to press the accurate action point to register the action, because of motor and vision problem. There are some actions which required to "tap and hold" the button to register an action, most of the time user failed to do it because the user "tap" the button but failed to "hold" it for few moments [6], [25], [30], [42], [43], [51]. Some application action buttons are mapped with matrix layout, the gap between one button to another is very less, special needs and novice users most of the time failed to trigger the correct button because finger shakes, they target the correct button to register but by mistaken finger "tap" the adjacent button and register the wrong function [25], [30], [40], [43], [45]. Some button requires "double tap" to register the action, but most of the actions failed to register by the users because special needs and novice users managed to do the "single tap" but the "second tap" timing and action points do not match with the application timing [25], [30], [43], [45]. The "double tap", "drag and drop" and "tap and hold" successful action registered accuracy is 65% by the special needs and novice users [26].

Experts suggest that matrix layout multiple buttons should be placed with 128 pixels distance from each other [2], [23], [43], and button dimension should be minimum 9mm height and width [12]. Tap gesture requires a single finger press or "single tap", a common practice to click any object and easy to remember, moreover experts suggest to implement "single tap" instead of "double tap", "drag and drop" and "tap and hold" [2], [14], [19].

4. DESIGN AND DEVELOPMENT

There are many usability problems has been identified for the special need and novice users by the experts. The proposed calling application is specially design for the special needs and novice users, designing time focus a minimum number of steps to complete the task, provide accurate information, consistent navigation, and "single tap" button press actions. A calling application has three major parts, firstly the dialer, secondly the receiver, and lastly the voice talk. The proposed calling application support only the single click or "single tap" interface to register an action, "multi tap" or "tap and hold" interface automatically register to a "single tap" by the application.

4.1 Dialer

Any kind of phone needs a dialer to make a phone call. A dialer required 0 – 9 digits number pad and a number input box to make an operator call. Different type of smartphone uses a different type of dialers to make a phone call. Most of the smartphones come with the Google Phone Dialer [41], which is designed for the trend of general users. There are few dialers for the people with special needs and novice users which can be found in the app store like Big Launcher [25], [33], [41], and Koala Phone [13], [14], [25].

Figure 1 illustrates the Google Phone Dialer [41], the application background color is white and the text color is blue which follow the design rules for the special needs and novice users [12], [14], [26], [32], [39], [43], but (a), (b) shows the gap between the buttons and the gap between buttons horizontally and vertically are not balanced moreover, the buttons do not have any border and the fonts are very small and simple in shape, which violate the usability rules [6], [11], [13], [14], [16], [18], [21], [25], [26], [28], [41], [43], [46], [47].

Figure 2 illustrates the Koala Phone Dialer [13], [14], [25]. The dialer keypad font color is white, font size composition and background theme color is black which follow the accurate usability rules [12], [14], [26], [32], [39], [43]. But (a) shows that the clock occupied half of the dialer screen, (b) the button background, border color are in black and no gap between the buttons, which violates the usability rules for the special needs and novice users [2], [23], [43]. The buttons should have borders with contrast color from the background moreover, numeric buttons should not contain any alphabetic value because the text input method auto call the default keyboard in the application.

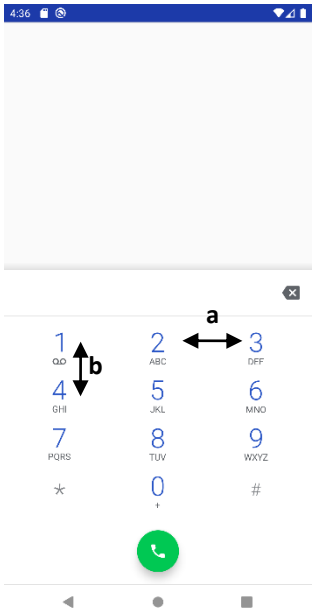

Figure 1: Google Phone Dialer Screen

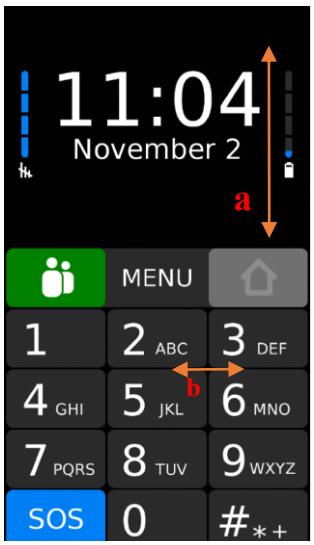

Figure 2: Koala Phone Dialer Screen

Figure 3 shows the Big Launcher Dialer [25], [33], [41]. The dialer buttons and number input box are very big, no other objects in the screen moreover, the button pads contains only the numeric values, which follow most of the usability rules for the special needs and novice users [12], [14], [26], [32], [39], [43]. But (a) shows there is no distance between buttons, which makes most of the uses press the wrong button [2], [23], [43].

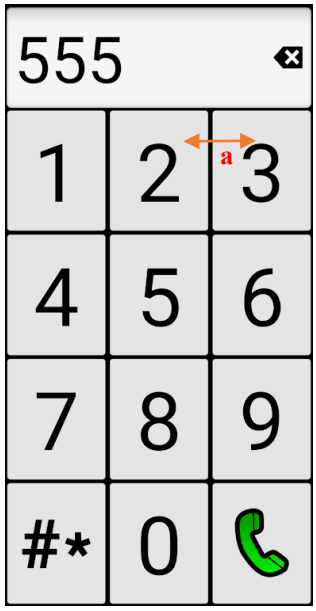

Figure 3: Big Phone Dialer Screen

Figure 4: Proposed Dialer Screen

Figure 4 illustrates the proposed dialer screen. The dialer keypad buttons are round shape, only numeric buttons, (a) shows the gap between buttons horizontally and vertically, the buttons background color is green and the font is white bold moreover, round shape button makes the user press in the center point of the button [12], [14], [26], [32], [39], [43], (b) shows the gap between the calling button and redial button. Button (c) is the calling button, the background color is bright green and the icon color is white, this button is used to make a call to the input number. Button (d) is the redial button, the background color is dim green and icon color is white, same way button (f) is the contact list and blue color, button (g) is the call history list and dim blue and both button icon colors are white [33], [39].

Figure 5 illustrates the dialer screen, (a) is the number input box which takes the number for calling, (b) hide the contact list and call history button, it makes the screen bigger and dials and redial button would be visible to the user to make phone calls.

Figure 6 shows the redial option screen, when the user presses the redial button for calling, then this option gets enabled. The number of retry (a) takes input, how many times the dialer will try to call the person, after trying if not managed to reach the number, the system will send an SMS to the dialed number. The message (b) stores the message context to the system. The benefit of this function, the user needs to dial once and the system will try to call the person several times if failed then send a reminder SMS to the dialed number. This algorithm (figure 7) will reduce the redundant work for the special needs and novice users. Normally every time users need to select the caller from the list and make the call, with this application user selects the caller and activates the redial, the system will dial the caller according to the user-defined parameter and each calling time will wait for 20 seconds to next dial. If the receiver does not receive the call then the system will send an SMS to the person to call back.

Figure 5: Proposed Dialer Expanded Screen

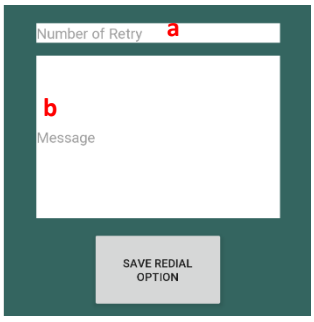

Figure 6: Proposed Redial Option Screen

The Figure 7 Illustrates the redial and message method algorithm. Line 1 is a while loop, the loop continues until the *numberofdial* is not equal to *count*, line 2 and 3 check whether the receiver received the call or not if received then return a null value, if not received then increase the *count* value and wait for 20 seconds at line 5. At line 8 return the *message* value. This algorithm runs whenever the user called anyone by redial option.

```
Input:
        numberofdial is the number of redial try;
        message is the SMS text context;
Output:
        message is the SMS text context;
Variables:
        count is zero;
Redial(numberofdial, message)
1.  while numberofdial is less than count
2.      if call received
3.          return null;
4.      else
5.          count ++; wait 20 second;
6.      endif
7.          endwhile
8.  return message;
```

Figure 7: Redial and Message Method

4.2 Receiver

After ringing the phone users either answer or decline the call. Three things are very common in the call receiver, firstly

caller information secondly, answer the call, and finally, decline the call. Figure 8 shows the Google Call Receiver screen [41]. The call receiver popup at the top of the mobile screen while someone is calling. The caller information (a) has two parts, one is the caller picture and the second is the caller number. The caller image and number both shown in the screen at very tiny in size. Decline button (b) with the redback color and white thin font; and Answer button (c) with greenback color and white thin color text. This design is not suitable for the special needs and novice users, most of the time they will get confused who is calling them and which button to take calls, because they have limited vision and cognitive capabilities [12], [16], [19], [23], [31], [39].

Figure 9 illustrates the Big Launcher Call Receiver screen [25], [33], [41]. The user information (a) with picture and name in the screen, the text and background color contrast is according to the usability rules [12], [14], [26], [32], [39], [43]. The reject button (b) height is small compare to the answer button (c) and the same time both buttons width is equal to the screen width. This issue would create human error while the special needs and novice users use the system. Unintentionally users would tap the answer or reject the button while they hold the mobile in their handgrip because of the motor problem [26].

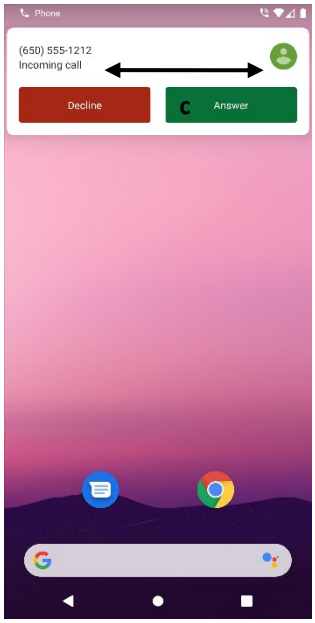

Figure 8: Google Call Receiver Screen

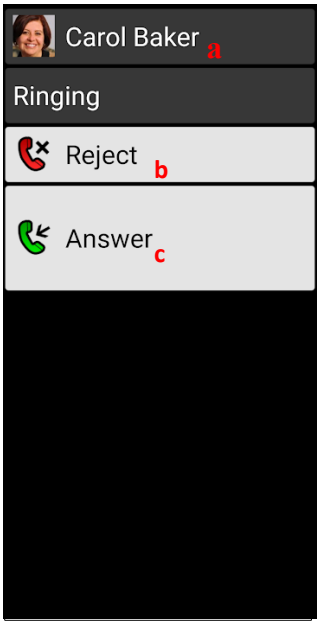

Figure 9: Big Launcher Call Receiver Screen

Figure 10 shows the proposed call receiver screen. The top of the screen (a) shows the caller picture, below the picture (b) shows the caller details, (c) is a simple animation to take attention from the user so they can interact in the receiving parts easily. Call deny button (d), feedback SMS button (e), and call receive button (f) green background and icons are bright color. These three buttons action register to "single tap". So, chances are very low to make errors by the special needs and novice users [2], [14], [19]. To avoid missing tap to the target action button add additional space to the button to register an action. Functionally to register an action user needs to tap inside the object. If the user taps outside of the object even one point then the "tap" would not get register for the action. The buttons (d, e, f) red line is pointed for extra additional space which is not visible to the users but if the user "tap" inside the red border line then the click would be registering for action.

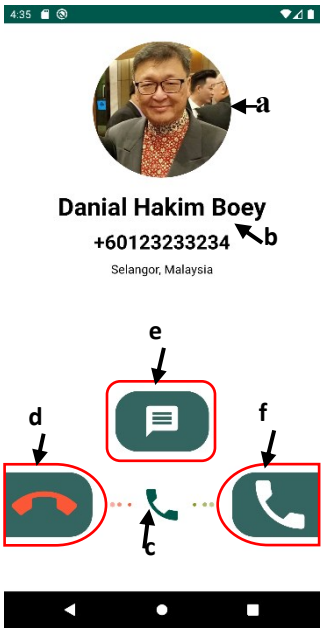

Figure10: Proposed Call Receiver Screen

Figure 11 shows the proposed action register algorithm. The main functionality of this algorithm, it received multiple and long press "tap" then converts them to "single tap" to register an action, add an extra *5 pixels* radius to each action object to receive an action event. Line 1 shows if the user *tapped multiple times* or *shake the finger* at tapping time or *long-press* then it converts to "single tap" and then registers the action for the event. Line 3 add 5 *pixels* additional radius space to each action object. So, the object will get an extra *5 pixel* space sounded side.

```
Input:
        clickaction is the register all type of actions;
Output:
        registeraction is the register click action;
Variables:
        screensize is the mobile screen size;
ActionRegister(clickaction)
1.      If clickaction is register for single tap or multiple tap or shake or
        long tap Then
2.    registeraction status to single tap;
3.  If buttonboundary is normal Then
4.    buttonboundary = add extra 5px boundary to all side;
5.  End
```

Figure 11: Action Register Method

4.3 Voice Talk

Talking time smartphone required one UI layer which is used when received a call from others and talk with someone after calling, in both cases the user needs to talk with another person. There is some common functionality used in the voice

talk application like a mute, keypad, loudspeaker, add call, call record, and hold moreover, few voice talk applications are developed only for special needs and novice users. Most of the android smartphone comes with google voice talk application, which is developed for the trend users, not for the special needs and novice users. Figure 12 shows the google voice talk application, at the top (a) shows the caller picture, name and phone number details, microphone mute (b) button, dial keypad (e) button, speaker mute (f) button, add new call (g) button and ongoing call hold (h) button. All the buttons contain icon and title but the title text is very small to read and the button does not have any background color, so the application does not follow the usability rules for the special needs and novice users [12], [16], [19],[23], [31], [39].

Figure 13 illustrates the Big Launcher Voice Talk screen [25], [33], [41]. At the top of the screen shows the caller details (a) information, end call (b) button, keypad (c) button, earpiece (d) button and hold button (e), all the buttons background color and title text size are designed according to the usability rules for the special needs and novice users [12], [14], [26], [32], [39], [43]. But all the buttons width size is equal to the mobile screen width size, which makes the button width (f) fully occupied the screen width. While the user talking with, they might press the wrong button unintentionally because they hold the phone by their hand grip and most of them havethe motor problem [25], [30], [40], [43], [45]. The button (c, d, e) icons are not meaningful according to their functionality, as a result, most of the users will make mistakes to select the correct button because most of the users suffer from cognitive problems [36].

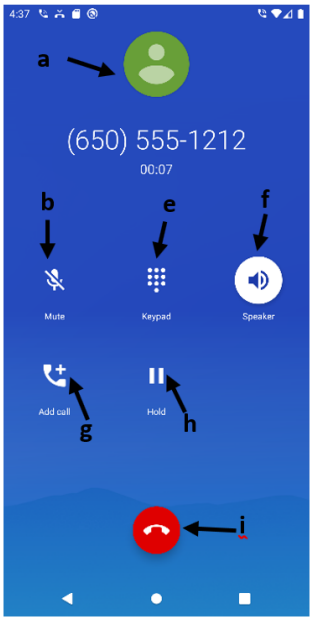

Figure 12: Google Voice Talk Screen

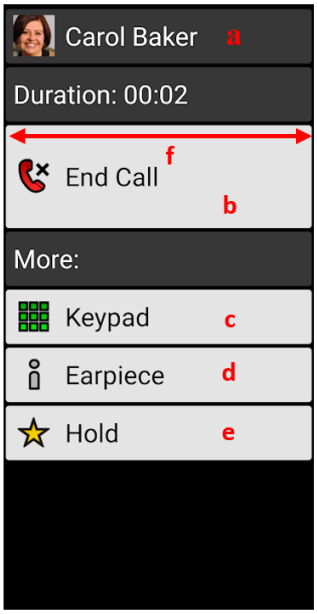

Figure 13: Big Launcher Voice Talk Screen

Figure 14 shows the proposed Voice Talk screen. The top of the screen shows the caller details information with picture, microphone mute (a) button, Numpad (b) button, loudspeaker (c) button, add call (d) button, call hold (e) button, call record (f) button and hang or disconnect (g) button. All the buttons use figure 11 Action Register Method to overcome the error. The disconnect (g) button is an animated *30 degree* up-down rotational graphical button. This is the most important functionality in the voice talk application. So, the animation will take the attention of the user. Another feature is added in this application for the special needs and novice users after received an incoming or outgoing call, the application put the call in a loudspeaker automatically, the user no need to turn on the loudspeaker, the user can talk with the loudspeaker until put the phone in the ear. Figure 15 illustrates the proximity sensor (a). When the user takes the phone near to the ear, the sensor (a) detects the human ear, sends a signal to the system, and the system stops the mobile loudspeaker and turns on the mobile ear speaker. Every time the user puts the phone on the ear, the ear speaker gets on and after a move, the phone from the ear the loudspeaker gets on automatically from the system.

Figure 14: Proposed Voice Talk Screen

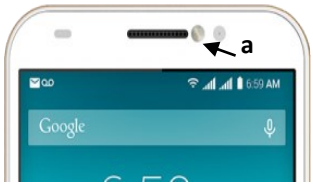

Figure 15: Mobile Proximity Sensor

```
Input:
        proximity is the proximity sensor data;
Output:
        spekaker is the speaker type earspeaker or loudspeaker;
SpeakerAssign(proximity)
1.  while proximity is sending live signal
2.      if proximity.data equal detectEar
3.          speaker = earspeaker;
4.      else
5.          speaker = loudspeaker;
6.      endif
7.  endwhile
```

Figure 16: Speaker Selection Method

Figure 16 shows the Speaker Selection method. Line 1 is a while loop and it runs until the *proximity* sensor sends the live signal, line 2 check the *proximity.data* is the human ear or not if found human ear then assign the *speaker* to *earspeaker* at line 3, if not then line 5 assign *speaker* to *loudspeaker*. This

algorithm runs each time when using the Voice Talk Application.

5. RESULTS AND DISCUSSION

Graphical User Interface design is not an easy task, especially when it designed for the people of special needs and novice users. There are various experts suggest developing UI for special needs and novice users. The interface design for the special needs and novice user is simple and plain, but it is a very hard task to design something which will be simple and easy to use [14]. The experts found that special needs and novice users received many calls from their family members and friends; and they make few calls from themselves [44]. Most of the special needs and novice users use few applications like calling, contacts, alarm, date and time, and video calls [44]. This paper focuses on the calling application. Table 1 shows four types of calling applications, first one is the Google Calling app [41], second is the Raku-Raku App [45],third one is the Big Launcher [25], [33], [41] and last one is the Koala Phone [14]. Among these applications, only Google Calling [41] is open source and the other three Raku-Raku, Big Launcher and Koala Phone are not open sources. The application code is required for four applications. The four application is platform-dependent and runs only in the android operating system. Moreover, all the applications are designed for people with special needs except Google Calling [41]. None of the applications is designed for novice users.

Table 1: comparison of Calling System Criteria

	Google Calling	Raku-Raku	Big Launcher	Koala Phone
Open Source	Yes	No	No	No
App code Required	Yes	Yes	Yes	Yes
Platform Dependent	Yes	Yes	Yes	Yes
Support Special Need Users	No	Yes	Yes	Yes
Support Novice Users	No	No	No	No

Table 2 shows the calling system UI and functionality which helps the special needs and novice users finished the task faster. Google Calling [41], Big Launcher [33],[25],[41] and Koala Phone [14] support "multi tap" action interaction but Raku-Raku [45] and Proposed System do not support "multi tap" action interaction. All the application UI is designed for special needs and novice users exclude Google Calling [41]. Proposed System and Google Calling [41] follow the navigation consistency but the other three applications navigation is not consistent. Big Launcher [33],[25],[41], and Proposed System navigation icons are clear which express the meaning of the functionality but the other three applications navigation icons are not clean and meaningful. All the five application objects are designed for the special needs and novice users so they can identify the objects easily. Only the Proposed System has Register Action to Avoid Miss Clicks, Auto Speaker Selection, and Redial and auto SMS sending mechanism, and the other four systems do not have these facilities.

Table 2: Comparison of Calling System User Interface and Functionality

Criteria	Google Calling	Raku-Raku	Big Launcher	Koala Phone	Proposed System
Support Multi Tap	Yes	No	Yes	Yes	No
Design UI for Special Need & Novice Users	No	Yes	Yes	Yes	Yes
Navigation Consistency	Yes	No	No	No	Yes
Clear Navigation Icon	No	No	Yes	No	Yes
Buttons are easy to identify	Yes	Yes	Yes	Yes	Yes
Algorithm to Register Action to Avoid Miss Clicks	No	No	No	No	Yes
Algorithm to Auto Speaker Selection	No	No	No	No	Yes
Algorithm to Auto Redial and SMS send	No	No	No	No	Yes

Table 3: Complexity of the Algorithms

	Time Complexity of Google Calling	Time Complexity of Proposed System
Register Button Action Method	*O(n)*	*O(n)*
Display Ringing Method	*O(n)*	*O(n)*
Display Voice Call Method	*O(n)*	*O(n)*

Time complexity is very important to understand the algorithm performance. The time complexity depends on the flow of the

algorithm. The algorithm complexity gets higher if it uses any nested operation [52]. Table 3 shows the time complexity of the Google Calling Application [41] and Proposed System, where *O* denotes the growth of a function, and *n* is the number of steps. The Register Button Action Method, Display Ringing Method, and Display Voice Call Method growth and time complexity are almost the same between the two systems. But there are differences in the execution time because of the dependency, which is related to the interaction method, object response time, and machine performance.

6. CONCLUSION

People with special needs and novice users use the mobile application in diverse ways from the trend users. The mobile industry thinks about making business with trends and none of them think about the special need and novice users. Recently government officials and non-government organizations are working on creating a smooth communication path with the younger generation and special needs and novice users. Most of the special needs and novice users scared to buy a smartphone and they are happy with the feature phone. Our main objective of this application is to minimize the mental phobia of using smartphones and provide special needs and novice users new experience of smartphone usability.

In this paper, proposed and developed a smartphone calling application. The UI design and functionality focused on the expert's suggestion and analyze the usability of the special needs and novice user's requirements, then developed the system. After development, compared the proposed system with other systems. The calling application has three parts, which focused on the color, text, navigation, and icon implementation by experts' suggestions and these parts were developed for special needs and novice users. The proposed algorithm will enhance the user experience and usability of the smartphone.

A vast work has been done for the special needs and novice users, but usability testing and evaluation need to be done in the next stage. The evaluation results will lead to the new era, may be new functionality and features need to be added, and existing functionality removed. So, in the next stage will do the usability evaluation by the special needs and novice users and from the results upgrade the existing system for general use.

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