Re-Engineering of A Virtual Igbo Keyboard In Standard Orthography Using Android Software Development Tool Kit

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Abstract- Localizing on-screen keyboard for communication in Igbo Language has brought about the existence of various Igbo keyboard on Android Operating System Platforms. Thus, the development of an Igbo Keyboard in Standard Orthography for Android mobile devices called AmandaX, which incorporates both the English Alphabet in QWERTY layout and the full Igbo alphabets in WERTY layout displayed in two different interfaces. This thesis made use of the ASCII (American standard code for information interchange) and Unicode Character sets to represent the development of the Igbo alphabets. It is hosted using the Android software development tool kit. Programming tools employed are Android Studio, Android software Development Kit, Android Virtual Device Manager (AVD), Eclipse Integrated Development Environment, Java Development Kit (JDK), and Adobe XD and Photoshop for the graphics. The result gives a user-friendly virtual keyboard which encompasses all the Igbo alphabets, their accents, and the diagraph consonants. One of the key benefits of AmandaX include masking passwords by allowing the user to use these Igbo accent characters for strong password creation. Also, individuals can now write quickly and communicate freely using this AmandaX.

***Index Terms*- Android, Igbo, Keyboard, Orthography, RAD**

I. INTRODUCTION

Nigeria is the most populous country in Africa [1]. Her population is estimated to be over 200.96 million [2], ranked as the largest population in Africa [3], and the seventh largest population in the world. It consists of over 250 ethnic groups, with over 500 languages, and variety of customs, and traditions among them, which gives the country great cultural diversity. The three largest ethnic groups are Igbo, Hausa, and Yoruba and their respective languages are spoken widely. The Igbo first encountered Europeans, the Portuguese and the British in the mid fifteenth century. In 1861, the British colonized Nigeria, influencing some of the linguistic and cultural aspects of Igbo people. Nigeria's National policy on education is a multilingual policy that allows a student to learn their mother tongue and English [4]. Thus, the Government of Nigeria in its basic education initiative included the study of Nigerian languages as a compulsory subject throughout primary and junior secondary school [5]. At the end, the West African Exams Council conducts exam of all subjects that include the local language studied by candidates before they move on to the Tertiary Level of their education after they have passed their Basic Education Certificate Examination. It is thus safe to conclude that every Nigerian who has gone through basic education in Nigeria is literate in the reading and writing of one local language.

Igbo (Asụsụ Igbo), or Ibo, is one of the largest languages of West Africa [3]. Over the years, It has been predicted [6] that at 2025, the Igbo language could go into extinction if the younger ones are not encouraged to fully embrace the language indicating the dwindling usage of Igbo language both in writing and spoken forms. Researchers have developed Igbo keyboard in the past, but it fell short of presenting the full alphabets of the Igbo language with its standard orthography. An explicit illustration is the Branah Igbo keyboard [7] is an online keyboard that enables the

user to type in Igbo language and other native languages. This is done by displaying an on-screen keyboard which displays the Latin alphabets in QWERTY keyboard layout. To type an Igbo character, the user must press the SHIFT KEY to get the u, i, o, Igbo characters which poses as a major gap and this work gives a possible solution to it by developing AmandaX which helps users print the Igbo characters in a single key.

Earlier research efforts developed a similar keyboard that could be used for Igbo and Yoruba languages, but for Mac and Windows platforms [8]. However, this research work is proposed for Android platform which appears to be the dominant operating system on smart devices. One of the devices the younger generations are attached to in smart devices, and if Igbo language could be embedded in these devices, it could promote the language. Therefore, this research paper aims at developing a soft keyboard that presents the full Igbo alphabets on mobile touchscreen devices replacing the usual QWERTY physical standard layout. The keyboard presents all the Igbo alphabets orthography or the Onwu orthography for individuals to communicate in their local language both in speech and in text. Nowadays, all the smart phone users connect with one another using their mobile phones on the go. Everyone is registered with some social network with which they connect with their friends. They share audio, video, text, articles, links, etc. over that network. Some of the shared audio or video or other form of multimedia is in their native language also. They also share links and articles over the internet that has other forms of multimedia in their native language [9].

This research work builds a localized soft keyboard on the Android mobile platform. Android is an open- source operating system used for smartphones and tablets. This means developers can modify and customize the operating system for each mobile device. The Android Operating system is based on the Linux kernel [10]. Android phones is the choice for this research work because it's widely used, and commands a market share of 85% [11]. It is also cost effective and user friendly.

The crux of the matter is that the existing Igbo Keyboard which only bears its characters in the normal English language alphabets has incomplete characters of the Igbo Alphabets. In effect, typing-in the Igbo language characters becomes stressful and individuals are forced to type in English language this will dwarf the growth of our mother tongue, Igbo, from growing stronger, endangering, and making it go to possible extinction. Other specific problems include:(a) Related works presents incomplete Igbo alphabets, including their Igbo orthography, (b) Extant keyboards present multiple characters to produce one Igbo orthography on a keyboard, (c) Tone marking of Igbo characters is insufficient, and (d) Inputting the Igbo characters involve a rigorous process. In this study, the following Igbo words and their meanings are used:

Word:	Meaning
Asusu:	Language
Onwu:	Orthography

II. LITERATURE REVIEW

Orthography is defined as the standardized rule set to writing a particular language. This comprises the standard letters used in writing same language. A transcribed form of Igbo language came into existence in 1861 [12], but there was a disagreement with the way it was transcribed. In 1961, Ọ́nwụ́ orthography emerged with the help of the Eastern Nigerian Government and this became the standard orthography that brought the prolonged disagreement to a halt.

This standard orthography is made up of the following 36 graphemes [13]:

{a b ch d e f g gb gh gw h i ị j k kp kw l m n nw ny ṅ o ọ p r s sh t u ụ v w y z }. This is made up of 8 **vowels (**a, e, i, ị, o, ọ, u, ụ) , 19 **consonants** (b | d | f | g | h | j | k | l | m | n | ñ | p | r | s | t | v | w | y | z) and 9 **blends** (ch, sh, gb, gh, gw, kp, kw, nw, ny**)** [14]**.** The Standard Igbo has aided in communication both in literary works and various educational purposes in school and other firms. The proposed Igbo keyboard alphabets adopts this pattern in its design.

Soft Keyboard: The first keyboard that existed was the typewriter, which was invented in 1867 and designed by Christopher Latham Sholes [5]. This keyboard printed characters by striking ink from a piece of etched steel onto paper forming letters on the head of the steel. Christopher Sholes improved on inventing newer models to advance the speed and efficiency and prevent the jamming of keys. Due to this flaw, the QWERTY layout came into existence. Its

initial layout was arranged in alphabetical order but the frequency of the letters 't' and 'h', caused the iteration to avoid the mechanical jams as seen in the typewriter still not considering ergonomics. Soft keyboards began with the evolution of the touch-screen phones in the market. The first touch-screen phone which was rather called the smartphone began with the innovation that is the property of the Int'l Business Machines (IBM) Simon Personal Communicator which was released in November 1993 by BellSouth corporation an American telecommunications holding company based in Atlanta, Georgia and distributed for consumers use on August 16th 1994 [15]. Android released their first smartphone ten years ago called the T-Mobile G1 also known as the HTC Dream [16]. This smartphone was bulky, heavy, and had a slide -out landscape QWERTY keyboard. The first android smartphone had the AZERTY keyboard layout on its invention. Subsequently, the QWERTY keyboard became the adopted keyboard for android phones in the English-speaking countries while AZERTY keyboard becomes used for the Francophone areas.

Android mobile operating system has gotten a global recognition as it comprises of a lot of consumers in the market. Its open-source feature has accommodated the usage and development of keyboards in numerous language varieties. Its platform has become so affordable to both the rich and poor, this has also in turn made technology popular in rural areas. The locals in our native villages operate smartphones as a mode of communication and for business transactions. Encouragingly, Android has provided a large community of developers and enthusiasts who develop a lot of great community projects because of its ready-made and customizable platform for high tech devices. Implementing the design of this Igbo keyboard, AmandaX, will go a long way in promoting the Igbo language and justify its usage on this mobile platform considering the affordability.

Android Software Development Kit

Android software development kit is a platform for the innovation and development of for the Android operating system [17]. Applications on Android platforms are typically established in Java programming language using the Android Software Development Kit (SDK) as well as other development environments and the Android Debug Bridge (ADB). The Android software development kit (SDK) consists of an all-inclusive set of development tools such as [18], (a) debugger (b) libraries (c) handset emulator (d) documentation (e) sample code (f) tutorials. Android applications come in .apk format and saved under /data/app folder on the Android OS (this folder can only be accessed by the root user for security purposes). APK package contains .dex files (this is a set of compiled byte code files called Dalvik executables), resource files, etc. The Android Debug Bridge (ADB) is a toolkit encompassed in the Android SDK package. The ADB comprises of both client and server-side programs that communicate with one another and characteristically read through the command-line interface. However, there are a lot of graphical user interfaces existing to control ADB. The format for issuing commands through the ADB is typically:

adb [-d|-e|-s <serialNumber>] <command>

III. RELATED WORKS

According to extant literature there are some already existing Igbo Keyboards in the market, however, these keyboards have also had their flaws. Branah.com [7] is an online keyboard that enables the user type in Igbo language and other native languages. This is achieved by displaying an on-screen keyboard which displays the Latin alphabets in QWERTY keyboard layout. To type an Igbo character, one must press the SHIFT KEY to get the u, i, o, Igbo character. This is one of the limitations of this keyboard because these are the only Igbo character it could present. The Q International QWERTY Keyboard [19] is another on-screen keyboard that enables the user type in Igbo language as well as other foreign languages that uses the Latin, Cyrillic or Greek alphabet. It comprises of the Dead and Held Keys which prints the characters needed for different orthographies on windows operating system. Yet, it does not produce the full Igbo characters. The Igbo typing keyboard is another on-screen soft keyboard that allows the transcribing of words in Igbo language using the Igbo keyboard alphabets [20]. This keyboard is not without its own flaws and functions like the Branah [7]. It makes use of the English alphabet QWERTY layout and do not display all the Alphabets of the Igbo Language with their orthography in line with these findings, further studies have been suggested. QWERTY keyboard, another on-screen keyboard used in the writing of some vowel characters of the Igbo alphabets involves the use of "Alt Codes" [21] to form the accents. These Alt Codes simply indicates a combination of the alt key and an arrangement of four numeric characters from the numeric keypad section combined to print an Igbo alphabet such as ALT+7882 for Ị, ALT+7883 for ị, ALT+7884 for Ọ, ALT+7885 for ọ, ALT+7908 for Ụ, ALT+7909 for ụ, ALT+7748 for Ṅ, and ALT+ 7749 for ṅ. Findings on this proves that it has been helpful so far in the typing of

the Igbo accents but still limited as one must have the combinations in his/her head to type effectively. This still propagates its study for further research as extant literature suggest that there is no work significantly done to address this shortfall on Android devices.

IV. METHODOLOGY

Rapid Application Development (RAD) methodology is the chosen methodology for this work. This methodology ensures a sustainable and cost-effective quality system is built for user needs. The methodology in figure 1 however has four development phases [22],namely; Requirement planning phase, User Design phase, Construction phase and Cutover phase.

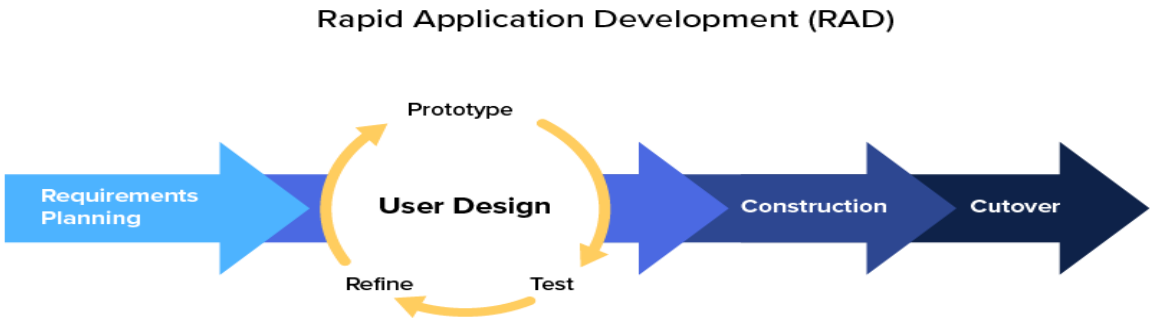

Figure 1: Rapid Application Development model [23]

Justification of RAD Methodology

RAD methodology adopted is justified with the following merits:

It gives better quality as users are actively involved in the process. The phases of planning till the implementation stage of the Igbo keyboard, the user gets involved to make corrections as regards the project.

It saves time, cost [22], and human effort. This is because all corrections during the development of the Igbo keyboard were seen and effected thereby making the project stress-free and saving time as well.

It provides the ability to quickly change system design [24] as demanded by the user. During the development of this Igbo keyboard there were bugs noticed at the implementation which were fixed. Also, the keyboard layout was initially placed in QWERTY layout which was quickly changed to finally have the Igbo alphabets arrangement.

Encourages feedback from the users and gives room for improvement. The methodology aided in allowing interaction during the development for greater success.

There is risk control at the early stage thereby making the entire development process effortless. Bugs were fixed at the early planning stage of the Igbo keyboard without destroying any developed stage on ground.

Unified Modelling Language (UML)

The proposed research work makes use of the use case and class diagrams under the unified modeling language (UML) notations in the development of the Igbo Keyboard. The intent here is deriving solutions to the identified problems or faults with focus on the available facts.

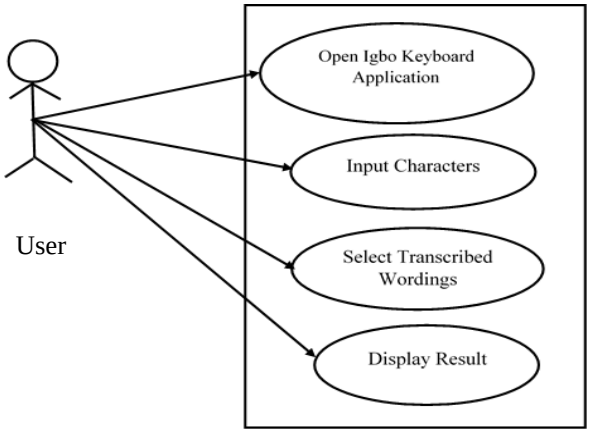

Figure 2: Use Case Diagram of the Proposed System

The figure 2 describes a user interaction with the Igbo keyboard noting its functionalities such as opening an installed Igbo keyboard in an Android device, the user starts keying some words. As the user goes ahead to key in words using the displayed alphabets, the system translates it and prints the characters which displays the result on the screen of the keyboard.

Data Flow Diagram (DFD)

Data flow diagram simply describes the flow of data through the proposed system showing the processes in a graphical representation. Figures 3 and 4 illustrated the data flow diagram that describes the inputs in the system, storage of data and as well displays the outputs on the Igbo Keyboard.

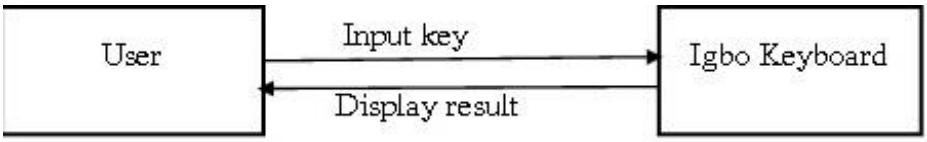

Figure 3: Level 0 Data Flow Diagram of the Proposed System

Figure 3 explains how the keyboard primarily operates. The user inputs a word by typing on the Igbo keyboard, the Igbo Keyboard receives it and then displays the words for the user on the screen.

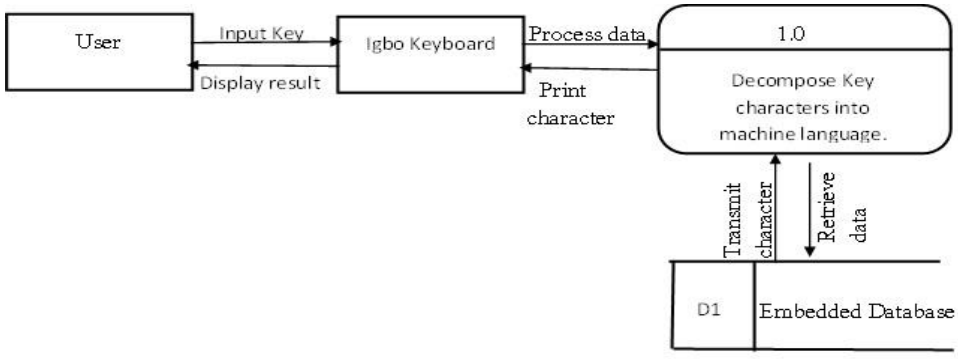

Figure 4: Level 1 Data Flow Diagram of the Proposed System.

The Level 1 data flow in figure 4 describes the overall distribution flow of data in the Igbo keyboard. The user inputs a word by typing on the keyboard, the Igbo keyboard receives it then process the words transcribed by decomposing the computations into the machine language and the retrieves the code from the data store embedded which transmits the characters printed back to be processed, prints the character and finally displays the result for the user.

Programming Language and Operating System

The soft Igbo keyboard was implemented using Java programming Language (Java SE 11.0.7 64 bits for Windows 10) while the operating system is Android hosted using the Android studio. The codebase of the Igbo Keyboard is made available online at Github in table 1 as a way to enable other software developers have access to the tools in other to create and develop similar projects in various languages.

Table 1: Codebase of AmandaX on Github

```
            }


            List<Key> keys = getKeyboard().getKeys();
            for(Key key: keys) {


                //Overdraw all keys with blank white Rect
                Rect rect = new Rect(key.x, key.y, key.x + key.width, key.y +
key.height);
                if (key.label != null) {
                    canvas.drawRect(rect, rectPaint);
                }


                //Draw little red symbol on following keys, but just on IGBO Keyboard
                if (!StringChecker(getKeyboard().toString(), idOfQwertyKeyboard)) {
                    if(key.label != null) {
                        if (key.label.equals("e")
                                || key.label.equals("u")
                                || key.label.equals("i")
                                || key.label.equals("o")
                                || key.label.equals("kp")
                                || key.label.equals("kw")
                                || key.label.equals("gb")
                                || key.label.equals("gh")
                                || key.label.equals("gw")
                                || key.label.equals("nw")
                                || key.label.equals("ny")
                                || key.label.equals("a")) {
                            canvas.drawText("∞", key.x + (key.width - (float)(key.width *
0.5)), key.y + 30, paint);
                        } else if (key.label.equals("sh")) {
                            canvas.drawText("s", key.x + (key.width - (float)(key.width *
0.5)), key.y + 30, paint);
                        }
                    }
                } else {
                    if (key.label != null) {
                        canvas.drawRect(rect, rectPaint);
                    }
                }
```

V. RESULTS AND DISCUSSION

The unit testing performance and the Android compatibility of the developed system, named AmandaX, is shown in table 2 and table 3. This process checks for error free codes and validates it while errors or bugs are debugged.

Table 2: Unit Testing Test Case for AmandaX

Test ID	Test Cases	Test Data	Expected Result	Actual Result	Status (Pass/Fail)
1.	Check whether the ordering of the keys is per QWERTY standard	AmandaX	The English interface should have the keys arranged in QWERTY style properly	All English alphabets are arranged properly in QWERTY standard	Pass
2.	Check whether the Igbo alphabets are arranged using the WERTY standard	AmandaX	The Igbo alphabets should be arranged in WERTY style removing Q and X.	The Q and X alphabets did not appear and it is purely WERTY style	Pass
3.	Check if all keys are functioning and present (Characters, numeric, functional, and special characters)	AmandaX	All keys including the space keys , delete key should work correctly	All keys are functioning accordingly	Pass
4.	Check if the font type is legible	AmandaX	The font type is times new roman and bold. It should be legible	The font type legible enough for the user.	Pass
5.	Check the colour requirement	AmandaX	The colour chosen should reflect a pink colour when installed.	The installed AmandaX showed a pink colour.	Pass
6.	Check the spacing between two keys is not congested	AmandaX	The 0.5 spacing should be suitable and not widely spaced	The spacing is accurate.	Pass
7.	Check if the keys are correctly named and printed	AmandaX	The keys should bear each alphabets correctly	Each keys printed the correct alphabets.	Pass
8.	Check the speed of printing characters	AmandaX	The keys should print the given character in a sec of clicking	The keys printed each character within a tap timely.	Pass
9.	Check the caplocks key functions.	AmandaX	The caplocks should change the letters to capital once held.	Thecaplocks functions accurately.	Pass

Table 3: Android System Compatibility Testing Test Case for AmandaX

Test ID	Test Cases	Test Data	Expected Result	Actual Result	Status (Pass/Fail)
1.	Check if AmandaX is compatible with two Android Devices	AmandaX, Android mobile phone	The AmandaX should work on the two different Android phones (S9 and S10)	The AmandaX functioned accurately.	Pass
2.	Check if the operating system is updated and see if it will work correctly	AmandaX	The update was done successfully and did not affect its functions.	The operating system was updated and installed successfully.	Pass
3.	Check for bugs and fix it also check it does not n't	AmandaX	The bugs are fixed.	The bugs are fixed and working perfectly	Pass

	affect the working condition.				
4.	Check that the apk is secure from known and unknown vulnerabilities	AmandaX	The apk should be secure.	The apk is secure and has a pop up warning the user of any vulnerabilities.	Pass
5.	Check that if new versions of operating system is updated that AmandaX will function correctly	AmandaX	The keyboard should function correctly after each update.	The keyboard functions correctly on S10 after the OS update.	Pass

Developed Keyboard Graphic User Interface

The developed soft Igbo keyboard, AmandaX,in figure 6 can be used in all applications on mobile devices with Android operating system. That is the SMS messaging, and social media like Facebook and WhatsApp for text inputting.

Figure 6: AmandaX Soft Igbo Keyboard User Interface

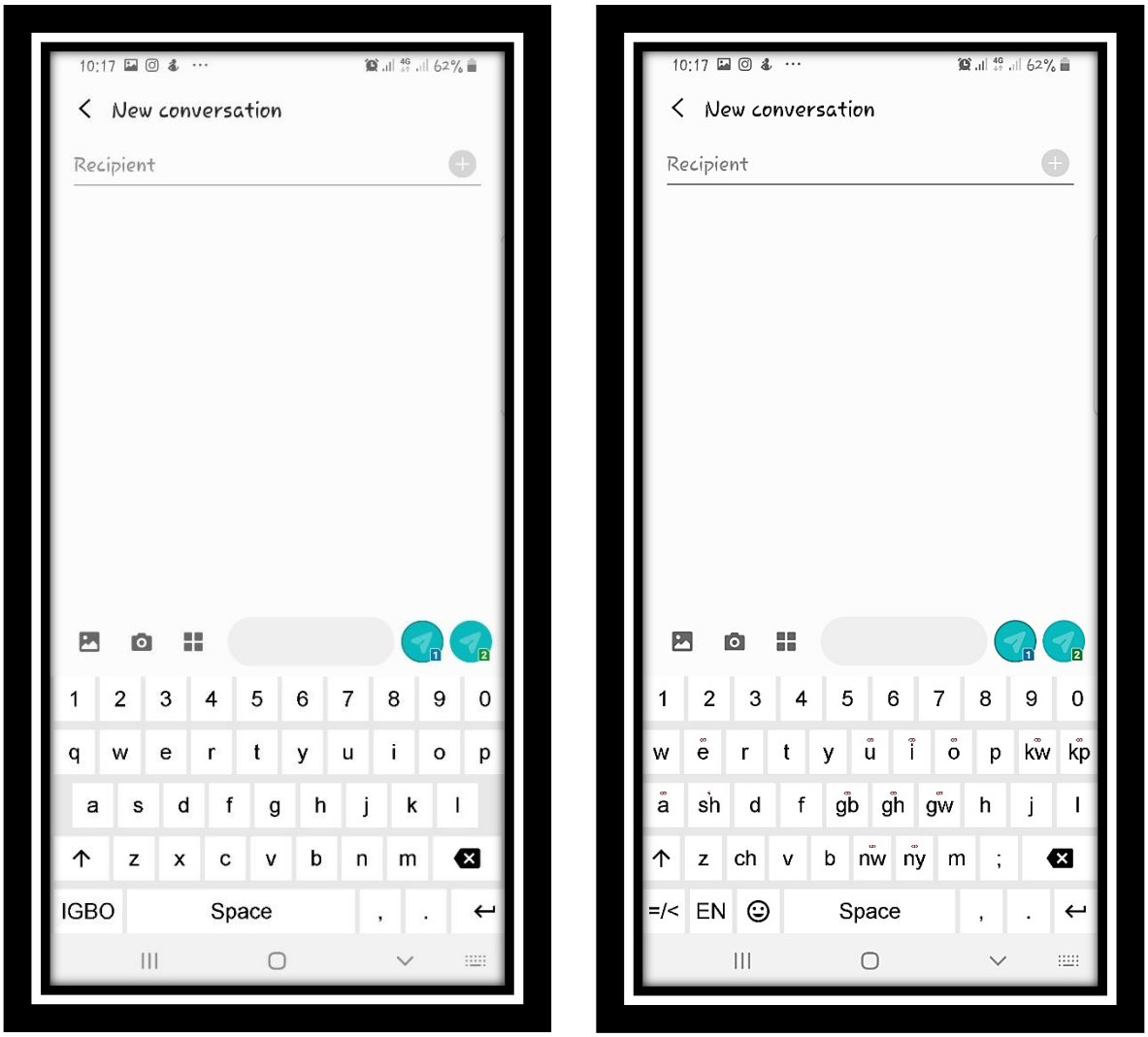

Figure 7: The Switched Keyboard Layout showing the QWERTY and Igbo Keyboard

Figure 7 shows the switching between the QWERTY keyboard layout and the Igbo keyboard layout.

Benefits of the developed System

The two test results suggest that the proposed soft Igbo Keyboard, AmandaX, fills up the gaps identified in the existing Igbo keyboards through the extant literature. These benefits include: low cost and full integration and compatibility with Android OS, which has a significant portion of the OS market base. It has a graphical user interface that is easy to navigate and intuitive. It is very easy to print characters as it displays both the QWERTY and WERTY keyboard layout thus showing all alphabets.

AmandaX Igbo keyboard will however close the gap of other existing keyboards thereby allowing the printing of Igbo accent characters in a single click on any application without having to combine different keys to print each accent. The consonant diagraphs are also printed in a single stroke also breaking the norm of existing Igbo keyboards. This will be useful for organizations to use in stronger password creations to curb frauds by social engineers.

VI. CONCLUSION

Localization of mobile applications for languages has become a vital and paramount concern in the IT world for users' sustainability. This research paper develops a soft Igbo keyboard for android mobile devices which functions on Android operating system that can aid and improve the communication of the native speakers of Igbo language. This Igbo keyboard was built on the Android operating system mobile platform due to the greater percentage of people using Android devices both in the rural and urban regions and it is also cost effective. This research work projects the Igbo keyboard as a hybrid solution that has both the English keyboard layout which is QWERTY and the Igbo keyboard layout in which the unnecessary letters not found in the Igbo alphabets like the Q and X are removed. This localized soft keyboard has successfully customized the input method to transcribe Igbo alphabets without combination of characters to print one Igbo accent, thereby attracting more indigenes into the usage and embracement of Information Technology.

This paper hereby recommends that organizations that conduct or execute confidential data to possibly engage in the usage of this soft or virtual Igbo keyboard in password creations to eliminate hacking or intrusion into the system by key loggers. Further research could focus on improving AmandaX that is platform independent.

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