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A Seamless Payment Approach for Mobile Network Operators in Nigeria

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Abstract
The major services provided Mobile Network Operators (MNOs) in Nigeria includes data, voice calls and short messaging service. Payment for any of these services could be through online platforms, short codes provided by financial institutions or the acquisition of recharge cards. Of these options, the recharge card acquisition option remains the most widely used in the country. Recharge codes printed on these small sized papers are expected to be carefully entered into subscribers' mobile devices before being authorized to use the services paid for. The errors and inconveniences that have characterized this payment option has necessitated the need for a more improved payment option. Therefore, this paper presents a seamless approach to MNOs payment. Performance evaluation report obtained from Twitter fabric's crashlytics tool revealed that the mobile application was 100% crash free when 48 volunteers used the application in 125 sessions within 3 months.

Keywords: *Mobile Payment Services, Mobile Network Operators, Recharge Cards, Optical Character Recognition, Unstructured Supplementary Service Data*

1.Introduction

The advent of Information and Communication Technology (ICT) as seen in mobile telecommunication industry in Nigeria has led to unprecedented economic growth in almost every sector of the country. It has practically redefined the way services and businesses are conducted thereby leading to a shift from the archaic analogue era to a digital era. According to the country's communication commission, out of an estimated 140 million populations, there are 139,144,705 active telephone connections in Nigeria (Subscriber Teledensity, 2017). It was also reported that the telecommunication industry contributed to 9.5% of Gross Domestic Product (GDP) of the country. Services provided by the industry are based on technologies such as mobile Global System for Mobile Communication (GSM), Code Division Multiple Access (CDMA), Fixed Wired/Wireless technology and Voice over Internet Protocol (VoIP). Mobile GSM has the largest market share of 99.7% subscribers followed by CDMA with 0.15% while fixed wired/wireless technology and VoIP have a market share of 0.1 and 0.03% respectively.

Services provided by the mobile GSM technology includes voice call, Short Messaging Service (SMS) and data. Unsurprisingly, these services are not free; they must be paid for using any available and convenient payment channels such as online platforms or via recharge cards. Several web platforms provide interfaces that permits subscribers to pay for preferred services using debit cards provided by their financial institutions. This option requires a high level of literacy and proficiency in the use of web applications before it can be used. Furthermore, there must be an assurance of internet connectivity; this connotes that, should a subscriber be totally out of data, the option cannot be used. In addition to the use of online platforms, a Pay as You Use (PAYU) scheme which provides secret codes aptly called recharge codes or pins could be used. These recharge codes are printed on papers or cardboards (popularly called recharge cards) and hidden under aluminum foils as shown in Figure 1. The recharge cards must be scratched in order to reveal the hidden recharge codes. Afterwards, the revealed recharge codes are expected to be entered into a

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mobile phone or any required device before access can be granted to the preferred mobile telecommunication service paid for. Though the approach is stressful and must be carefully implemented, it is the most widely used in the country (Mohammad, Barua, & Arafat, 2013).

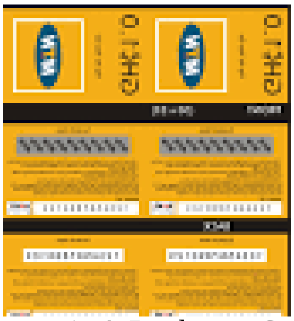
Figure 1: A Recharge Card

Major mobile telecommunication service provider in the country includes MTN Nigeria communications, Globacom limited, Airtel Nigeria and EMTS Limited (9mobile). As reported by Nigerian Communication Commission (NCC) in July 2017, MTN Nigeria communications remains the leading telecoms provider with 49,763,224 subscribers while Globacom limited has 37,242,918 subscribers. Airtel Nigeria can boast of 34,111,094 subscribers while 9mobile can boast of 17,614,362 subscribers. All these telecommunication service providers have their unique Unstructured Supplementary Service Data (USSD) communication technology that specify the text format in which subscribers will use to interact with the application program on their network in order to grant access to the service they've paid for.

For instance, MTN expects users to use *555*recharge_code#, GLO expects a subscriber to use *123*recharge_code#, Airtel expects a subscriber to use *126*recharge_code# while 9mobile expects *222*recharge_code# to be used by a subscriber. As simple as these steps seem to be, not all subscribers can accurately employ them in paying for their services. Also, to reveal a recharge code on a recharge paper, subscribers are expected to scratch the aluminum foil from the surface of the recharge cards. Most times while trying to scratch this aluminum foil, the recharge codes may be scratched along. If the attempt is successful, subscribers are expected to enter the revealed recharged codes on their mobile devices in the specified USSD format before the access to the services being paid for can be granted. A lot of time is expended in this process which is prone to error as a recharge pin may have up to a sequence of sixteen numbers. Repeatedly entering wrong recharge codes three times may lead to the blockage of individual's mobile line.

Furthermore, the increasing popularity and penetration of smartphones in Nigerian mobile phone market is responsible for the digital revolution seen in different sectors of the country. A report released by eMarketers-a digital content provider- showed that with 74.6 million mobile phone users; which is estimated to increase to 84.5 million in 2019, Nigeria has the largest number of mobile phone users in Africa (Cindy, 2005). Of these, 15.5 million people are smart phones users which is estimated to increase to 23.3 million in 2019. Besides the mobile operating system which provides a platform for increasing mobile applications, embedded hardware features such as high pixel camera is another unique features of smartphones. This paper leverages on the powerful smartphone camera and its flexible operating system to redefine the existing error prone and time consuming mode of mobile telecommunication services payment.

2.Related Works

A web platform "eCard" developed for mobile telecommunication services payment was introduced by Frank, Samuel, & Emmanuel, (2011). A subscriber is expected to open an account with them in which a certain amount of cash would have been deposited for the purpose of recharging their mobile phones. After this, the subscriber is expected to log in to his account and supply his mobile phone number after which a chosen amount of recharge code will automatically

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be credited into his account. A similar web platform; an e-commerce website was also proposed in Boutahar, El Hillali, El Ghazi & El Houssaïni, (2014). It allows subscribers to use their debit cards to acquire any service of interest via their debit cards. Though this method has been proved to be functional, trust issues as regards the need to reveal subscribers bank and credit cards details remain an issue of concern. Also, the process is time consuming and requires a level of literacy, expertise and technical-know-how before the web applications can be used.

In contrast, a multi-purpose recharge code acquisition Point of Sale (POS) terminal as shown in Figure 2 was introduced by Airtime Vending Products, (2017). This is a small, moveable POS terminal that can permit individual to purchase recharge codes among other services for the purpose of paying their mobile telephone's services.

Figure 2: Recharge Card Vending POS Terminal (Airtime Vending Products, 2017).

Users of this POS are expected to purchase the POS and subsequently pay a certain amount of cash into the manufacturer's account. The cash deposited will be used to transact certain e-businesses including recharge pin vending. The POS has an inbuilt thermal printer and a slot for inserting a roll of carbonized paper for the purpose of reeling out the processed recharge codes as recharge cards. Besides time needed to deposit cash in the bank in order to transact business on this POS terminal, technical-know-how about the function and use of this terminal is a challenge. The cost of acquiring the POS terminal is also on a high side which has greatly reduced its acceptability among individuals except those who intend to use it for business purposes.

Conclusively, three approaches to telecommunication services payment were suggested in Northstream White Paper, (2019). They are retail top-up, bank top-up and direct operator top-up. The retail top-up approach is an electronic top-up option that allowed the value of the service paid for to be provided without a need for the user to enter recharge codes on their mobile devices. Bank top-up option allows subscribers to employ Automated Teller Machines (ATM) or online web applications to transfer funds from their bank accounts into the mobile telecommunication operator prepaid account so that they will be credited with the value of the services paid for. The direct operator top-up are top-up channels being managed by registered mobile telecommunication services operator. To use the option, subscribers are expected to provide the operators with their debit card or bank account details so that they can in turn use voice prompts or certain graphic user interfaces to acquire a service of interest. Though, these options are non-cash payment options that requires payments through subscribers' financial institutions or debit cards, however, ease of payment, technical-know-how and trust issues remain a major concern of these options. This paper presents a seamless payment approach to mobile network operators' services payment. The approach is seamless because its less stressful, requires few steps and little technical-know-how.

3. Materials and Methods

The mobile telecommunication services payment approach presented in this paper provides solution to the inherent errors that occur during the process of scratching a recharge card with a view to reveal the recharge codes. It also saves subscribers the stress of entering revealed recharge

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codes on their mobile devices before access can be granted to the telecommunication services being paid for. It leverages on the powerful camera of smartphones to capture the image of a recharge card. Afterwards, the principle of Optical Character Recognition (OCR) was used to extract recharge codes from the captured recharge card image. The extracted recharge codes are then automatically processed to extract respective mobile telecommunication service providers' USSD information needed to provide the required service.

3.1. Technologies Employed

The following technology were employed to implement the seamless payment option

a) Recharge Code Extraction using OCR Technology

OCR permits the extraction of printed or written text from a document. Prior to the application of OCR technology for the extraction of recharge codes from recharge cards, a smartphone's camera was used to capture the image of the recharge card. Afterwards the OCR technology was employed. There are several publicly available OCR engines for this purpose. However, the most accurate open source OCR Engine-Tesseract which was initially developed by Hewlett Packard and later acquired by Google was adopted and modified to extract recharge codes from the captured recharge card image. Tesseract provides three types of OCR engines; they are:

i. TesseractOnly: which is the fastest of the OCR engines however it is the least accurate
ii. CubeOnly: this employs the concept of artificial intelligence to improve the accuracy of TesseractOnly, nonetheless it is slower
iii. TesseractCubeCombined: this combines the strengths of the previous OCR engines to provide the most accurate of the OCR engines. This was employed in this paper.

Furthermore, the Tesseract-OCR code was modified to recognize paragraph breaks which are used to partition the recharge codes into a group of four characters.

b) Optical Character Recognition Algorithm

As documented in Smith, (2007), the following algorithm was used to implement the Tesseract based OCR:

Step 1: Start.
Step 2: Capture the recharge card image.
Step 3: Employ adaptive thresholding to convert the image into binary images.
Step 4: Employ connected component analysis to extract character outlines.
Step 5: Convert the extracted character outlines into Blobs
Step 6: Organize the blobs into text lines
Step 7: Analyze the text lines to ensure they have the required character length, font size and font type. This is dependent on the respective service provider
Step 8: Employ definite spaces and fuzzy spaces to divide the texts into individual character
Step 9: Employ a two pass adaptive classifier to accurately recognize each character
Step 10: Display the final characters
Step 11: Stop.

3.2. Mobile Application Development

An android based mobile application was developed to implement the Tesseract-OCR character recognition, recognize the respective mobile telecommunication service provider and append the appropriate USSD codes after which the mobile device dialer application was started via

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the android StartActivity() intent. To ensure a smooth development was achieved, the following hardware and software requirements were put in place:

a) Hardware Requirements

a) Processor: At least 1.0GHz Multicore Processor
b) Memory: 512 MB RAM
c) Hard disk Space: 50 MB Disk Space
d) Camera: At least 2.0MP camera

b) Software Requirements.

The system requires at least Android OS version 4.1 to successfully run

c) Development Tools.

The following programming tools were used:

i. Java 2 Micro Edition (J2ME) was used for the implementation of most aspect of the work. It was used to modify the libraries of the Tesseract and Cube OCR which were initially written in C++. It was also used for identifying the respective mobile service provider and integrating their USSD code before forwarding the information to the dialer application of the mobile devices. Some sections of the Graphic User Interface (GUI) were also designed in Java.

ii. eXtensible Markup Language (XML) was used to support Java in the design of the GUI. All user interface widgets were defined in XML and linked back to the Java code with unique Identifiers. This facilitated decoupling of the GUI and the business logic of the system.

4. Results and Discussion

The following screenshots describe in details the operation of the developed mobile application. Figure 3 illustrates the recharge code capturing from the recharge card. It is the responsibility of the user to ensure that the recharge code falls within the rectangular overlay of the mobile application. Figure 4 shows the extracted recharge code being displayed on the screen and the respective correctly predicted service provider. Furthermore, it is the responsibility of the user to ensure that recharge code has the right orientation as this may lead to a wrong recharge code extraction as shown in Figure 5. A splash screen that shows the recharge process where the USSD information of the service provider is affixed to the extracted recharge code prior to the activation of mobile device dialer application is shown in Figure 6.

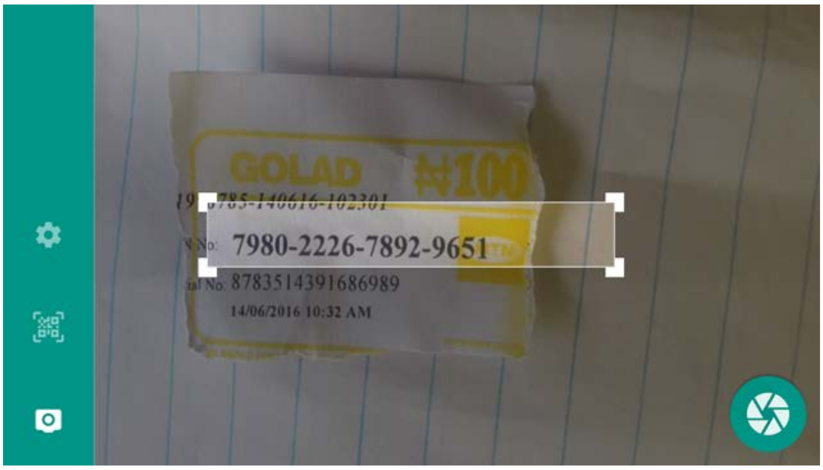

Figure 3: Recharge Code Capturing Attempt

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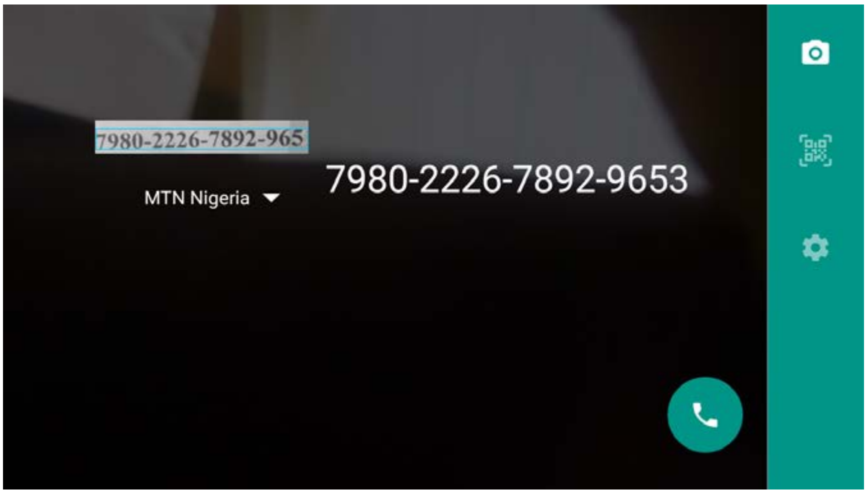

Figure 4: Correctly Extracted Recharge Code and Correctly Predicted Service Provider

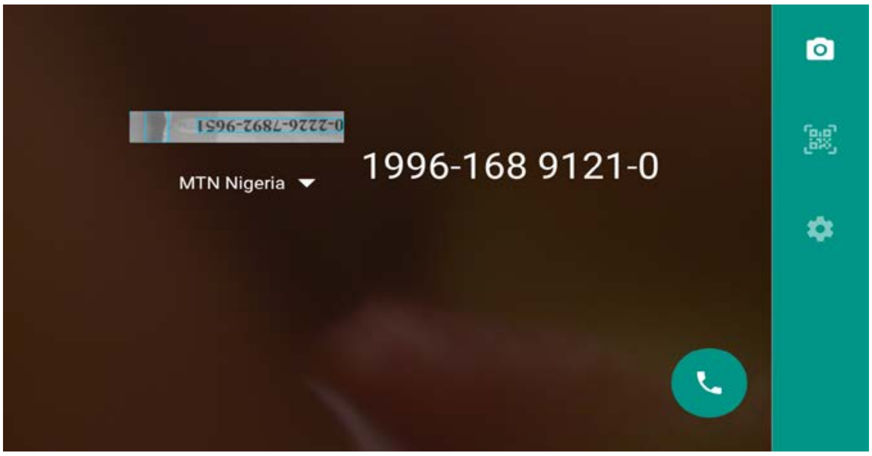

Figure 5: Wrong Data Capture as a Result of Wrong Orientation

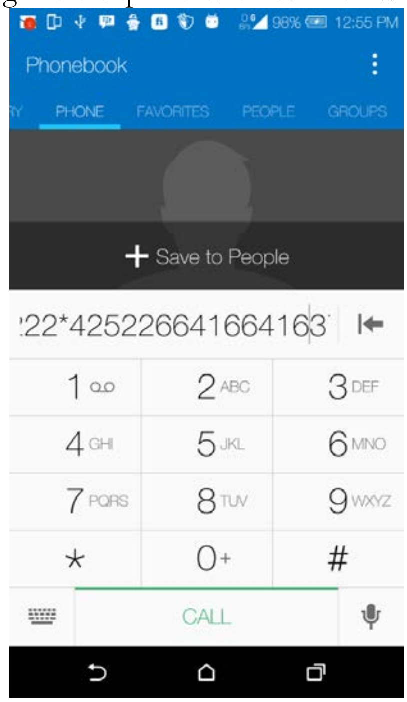

Figure 6: USSD Code being Affixed to the Extracted Recharge Code

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A message indicating a successful recharge process is displayed to the user as shown in Figure 7. Users of the application can alter the behavior of the application though its settings option so as to limit the number of flash screens that will be shown. If the auto mode is enabled as shown in Figure 8 immediately after recharge code extraction, the next information to be displayed will be the splash screen indicating a successful recharge.

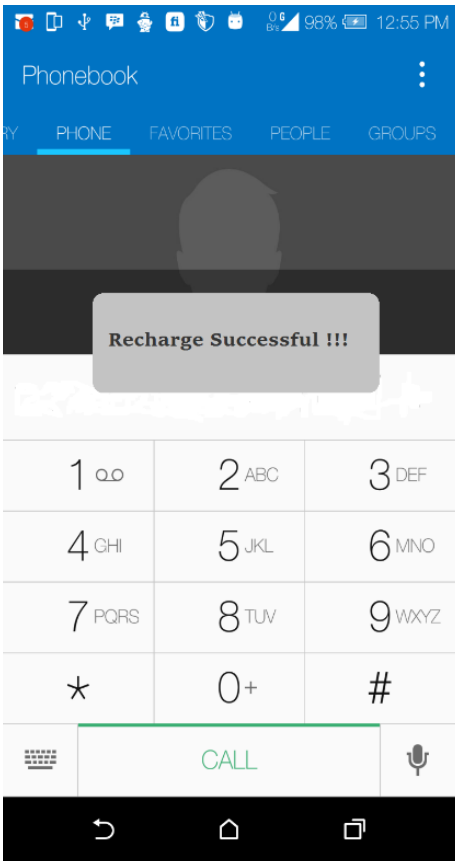

Figure 7: Successful Recharge Page

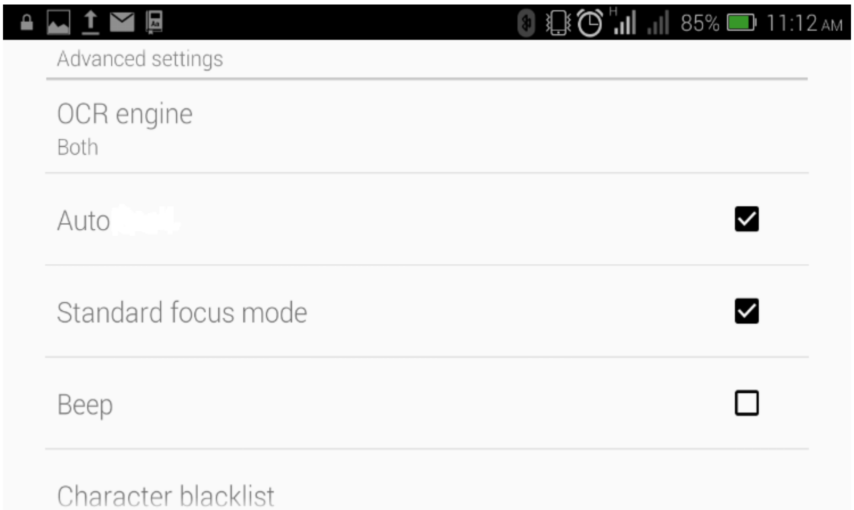

Figure 8: Settings Page

4.1. System Testing

Prior to the system testing, unit testing of the mobile application was carried out using Roboelectric. Roboelectric is a unit testing framework that provides a Java Virtual Machine (JVM) compliant version of the Android Software Development Kit (SDK) jar. This permits developers to write codes to test each units of their android application and run them on desktop JVM while still using the Android Application Program Interface (API). After a successful unit testing, a user acceptance testing (beta testing) of the mobile application was carried out using Twitter fabric's crashlytics tool. This was conducted among 48 volunteers who used the application for three months. Initial crashes were reported when lower android versions were used, when there was low memory space in volunteers' mobile devices or as a result of programming bugs. Information about these crashes were gathered and reported by the Twitter fabric's crashlytics tool. Initial crash reports as shown in Figure 9 revealed that 33 crashes were experienced among 19 volunteers; these occur between 11th and 18th of June, 2017. When these bugs were fixed, the crashlytics report obtained as shown in Figure 10 revealed that out of 125 sessions among the 48 monthly users the mobile application was 100% crash free. This showed an improvement over the initial crash report obtained.

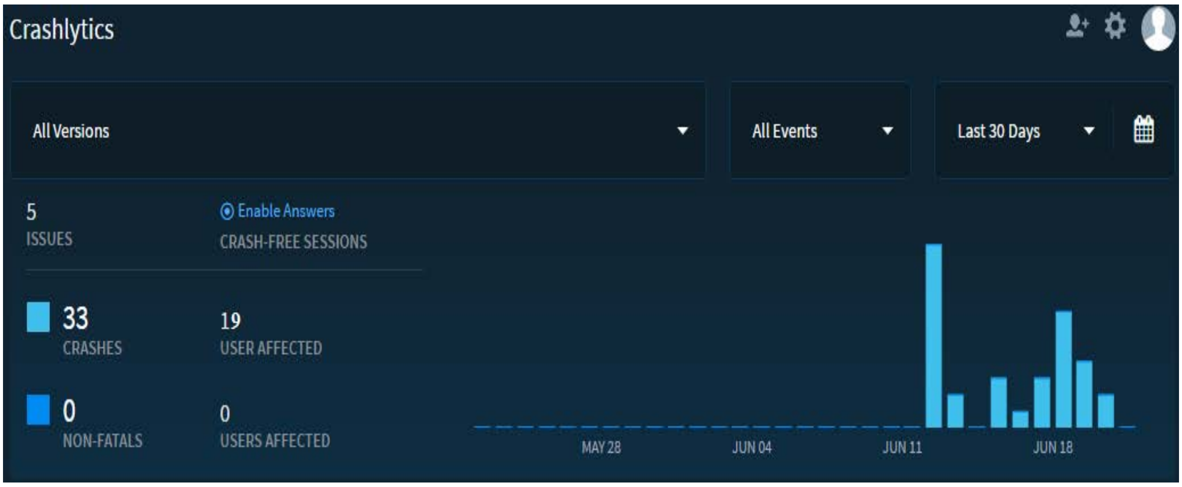

Figure 9: Initial Crash Summary

Figure 10: Final Crash Summary

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5. Conclusion

A seamless approach to mobile telecommunication service payment that leverages on smartphones' camera and the flexible Android operating system that houses several mobile applications has been presented in this paper. The smartphone's camera was used to capture the image of a recharge card while the mobile application used the principle of OCR to detect and extract recharge codes from the captured recharge card image. The mobile application was programed to extract service provider's USSD information which were added to the extracted recharge code and later forwarded to the dialer application of the mobile devices. Twitter fabric's crashlytics tool was used to evaluate the robustness of the developed mobile application. Results obtained revealed a 100% crash free experience when 48 volunteers used the application for 125 sessions within three months.

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