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A Novel Mobile Wallet Based on Android OS and Quick Response Code Technology

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Abstract
The emergence of Android mobile operating system has brought about a huge change in the smart phone industry. It has contributed to the increase in the range of services a smart phone can provide which includes the ability to be used in the exchange of financial value. Quick Response (QR) code technology can be regarded as a key technology in the future of mobile payments. The goal of this paper is to develop a model of mobile payment solution using QR code as a communication link between the two parties engaging in a transaction and also for encryption of transaction details. The study resulted in a new android mobile wallet application which was developed using the object oriented analysis and design methodology. Our experimental results show that the new system has better security using dual authentication employed by different entities, does not require sharing of personal details, eliminates the need for agents in the payment ecosystem and satisfies the universal property

Keywords
Mobile wallet, QR Code, Transaction protocol, Mobile payment

I. Introduction

The exchange of financial value has evolved from trade by barter to physical notes, cards and today mobile phones are trending in the industry. Today smart phones are the equipped devices that are used in many different sectors such as business, healthcare, social networks, environment monitoring safety and transport.[1] Smart phones have become an alternative for personal computers, emerging as a mobile computation device [2]. A mobile payment has been defined as "any payment where a mobile device is used in order to initiate, activate, and/or confirm this payment" [3]. A mobile wallet is an "app" for your smart phone or tablet that allows you to organize your payment cards, coupons, vouchers and identification to facilitate financial transactions [4]. Mobile payments can be differentiated based on various characteristics, including the technology used and the transaction size, location, and funding mechanism [5]. The main drivers behind the success of mobile payments are the explosive growth in the number of mobile devices and the fall in the cost of computing power.

Mobile payments are of two categories: proximity and remote. Proximity payments are payments made in such a way that both the sender and the recipient are in close distance or the same physical location. This type of payments requires physical interactions between the both parties involved while remote payments are payments made when money transfers are done over a distance and does not require physical interaction of both parties.

Quick Response codes have their origin traceable to the barcodes. They are actually 2-dimensional barcodes whose major advantage over the barcode lies in its ability to store larger amount of data than barcodes. The development and use of barcodes was catalysed by the need to speed up the transaction process and track inventory as well. QR was developed by Denso Wave, a Japanese company affiliated to Toyota. QR codes was initially invented to track parts in vehicle manufacturing but today it is used for almost everything ranging from advertisement to mobile payment and ticketing [6]. It also makes the process faster by reducing the number of user inputs. Using QR codes requires one party to generate the QR code and the other party to scan the QR code; it therefore requires the physical interaction of both parties therefore inclined to the proximity type of payments. The

objective of this study is to develop an android mobile wallet system that has better security in terms of authentication and privacy, quick and easy to use, satisfies the universal property and guarantees payer control while making use of the Quick Response code. QR codes enable to access anytime and anywhere to companies' websites that are designed considering consumers' involvement in some business processes (e.g. service improvement) and considering consumers' satisfaction realized through interactive communication enabled by various services and tools used at websites [7].

II. Related Works

For us to effectively analyze the mobile payment ecosystem, a proper review of the literature is required. We have observed that before the year 2006, studies on QR code were few hence the existence of limited literature, but from 2007 till date it has become a very interesting area of research and use. Such works in the literature includes;

Sudheer V. et al, in their paper titled " secure ciphering based QR pay system for mobile devices", developed a secure QR pay system based on QR code by expressing a 2 dimensional code which can pay things between the user and the shop while offline. The system provides non-repudiation and confidentiality of payment information.[8] Suresh G. et al in their work titled Secure QR-Pay System With Ciphering Techniques In Mobile Devices presents an innovative mobile payment system based QR-codes for mobile users to improve mobile user experience in mobile payment. Unlike other existing mobile payment systems, the proposed payment solution provides distinct advantages to support buy-and-sale products and services based on QR codes. A merchant shows payment information by expressing QR-code to display window. A user shots a situation by using mobile Device attached a camera. The system provides non-repudiation and confidentiality of payment information. Also, it offers mutual authentication between user and merchant.[9] Abhijeet B. et al in their paper titled " QR code based mobile application and business integration developed a cost effective mobile payment system using the QR code technology. [10] Miroslav S., in his thesis titled implementation of payment protocol on NFC-enabled mobile phone examined feasible solutions for implementation of payment protocol on the NFC-enabled mobile phone (with Android operating system). An important part of the thesis is the description of the implementation of three different payment

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methods. Further, the application is tested with respect to the speed of communication for different types of public key algorithms, key lengths and types of certificates.[11] Pinto D. in his paper titled QRP: An improved secure authentication method using QR codes presents the design and implementation of QRP, an open source, proof-of-concept authentication system that uses a two-factor authentication by combining a password and a camera-equipped mobile phone, acting as an authentication token.[12] Katharina et al in their paper titled QR code security examines QR Codes and how they can be used to attack both human interaction and automated systems. As the encoded information is intended to be machine readable only, a human cannot distinguish between a valid and a maliciously manipulated QR code. While humans might fall for phishing attacks, automated readers are most likely vulnerable to SQL injections and command injections. They also did an analysis of the QR Code as an attack vector, showing different attack strategies from the attackers point of view and exploring their possible consequences.[13]

After examining existing literature, we found out that all authentication procedures were undertaken by a single entity even though some authentication processes are two- factored. This is a major weakness and we therefore seek to extend authentication processes to be undertaken by two distinct entities to provide more security. This study centers on the development of an android based mobile wallet using the QR code technology for encryption and communication.

III. Analysis of The Android Mobile Wallet

In the Peer-to-Peer Model, the payment service provider deploys the mobile payment system which acts as a peer-to-peer service, while providing mobile payment services to customers and merchants. The service provider ensures that transactions can only be between customers with an active account with them. The system also requires the services of agents or exchangers in order to assist users to register accounts, fund accounts or withdraw cash. Fig. 1 shows the sender and the receiver connected together on the platform of the payment service provider. The transaction and exchange of financial value are performed directly by the service provider and the agents and sometimes banks are used in the funding and withdrawal processes.

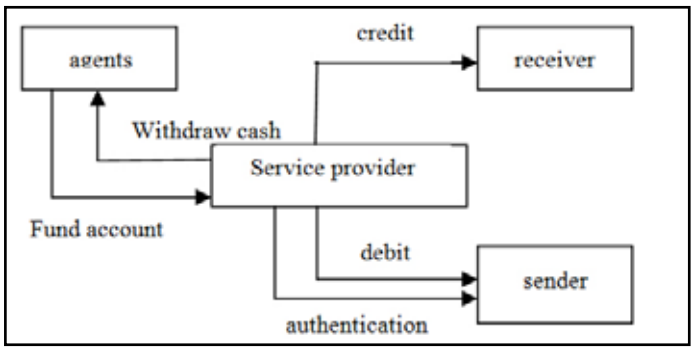

Fig. 1: Peer to Peer Model

The new system extends the peer to peer model as shown in Fig. 2, the receiver and sender converge at the service provider application or platform to be able to receive money and pay money as well. The service provider after successfully authenticating the customer /sender, sends a transaction request to the financial network with the banking details of both the sender and the receiver. The sender's bank under the financial network authenticates the sender and if successful, executes the transaction.

The financial network is made up of major financial institutions like banks, credit card companies, mobile network operators and other financial service providers. All of them form a network that is united on a unit platform to efficiently process financial transactions and also overcome problems associated with inter-operability. As shown in Fig. 3, at the core of the financial network is the Transaction Centre TC, which directly connects to all participating financial institutions. The job of the Transaction Centre is to ensure successful management and execution of transactions that come to the network. It is responsible for debiting the sender's bank and crediting the recipient's bank accordingly.

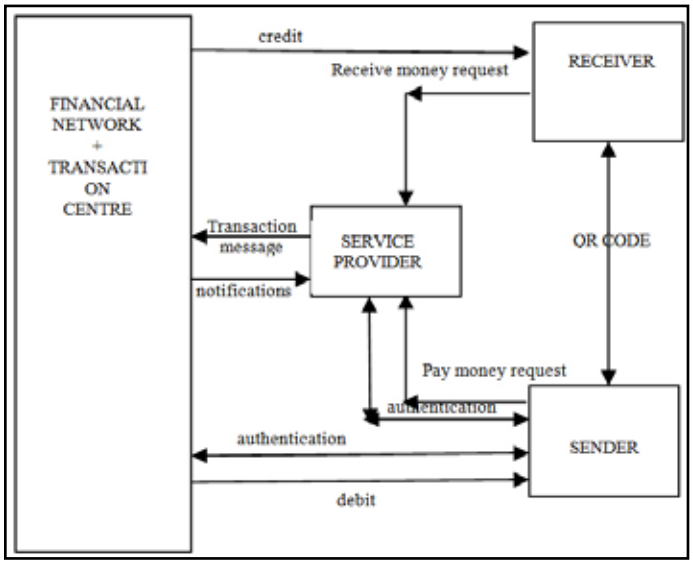

Fig. 2: Proposed Mobile Payment Model

Once the network gets notified of an incoming transaction from the trusted third party application, the message is redirected to the transaction centre who decodes the message, and notifies the financial institutions that will be involved of the impending transaction. The Customer's bank account checks the customer's details, verifies him usually through an authentication process and checks for sufficient balance before it is debited and the recipient's account credited accordingly.

A user is expected to download the mobile application and configure an account before first use. He will also be able to perform the following tasks after registration

1. Pay Money
2. Receive Money
3. Add Money Account
4. Edit Profile
5. View History

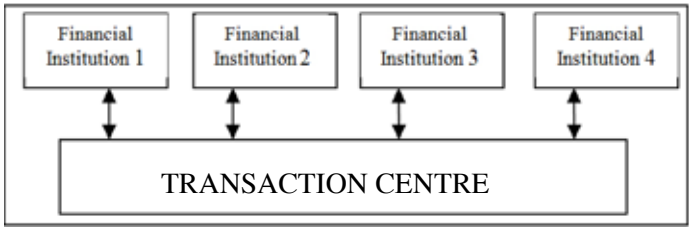

Fig. 3: Financial Network Architecture

IV. Implementation

In any software development process, it is very important to use the right methodology which will suit the problem one is trying to solve. For this study, we made use of the object oriented analysis and design methodology since Android applications are developed using java programming language which emphasizes

on modularity and reusability. Android is a new, next-gen mobile operating system that runs on the Linux Kernel. Android Mobile Application Development is based on Java language codes, as it allows developers to write codes in the Java language. These codes can control mobile devices via Google-enabled Java libraries [14]. The system was developed using the Android Studio IDE. The Android Studio Designer tool provides a "what you see is what you get" (WYSIWYG) environment in which views can be selected from a palette and can toggle between design mode and code mode. The device screen provides a visual representation of the user interface layout as it is being designed. This layout allows for direct manipulation of the design easily in terms of what you see is what you get. The application uses barcode scanner from the open source project ZXing. Zebra Crossing (Zxing) is a multi-format 1D/2D barcode image processing library which can be used to create and read QR codes.

V. Transaction Algorithm

1. Users launch the application from their android mobile device
2. The receiver selects receive money
3. Receiver enters amount and selects currency
4. Receiver clicks ok and a QR code is generated by the system bearing the receivers account details and necessary transaction information.
5. The receiver presents the QR code on his mobile device to the payer for scanning
6. The payer scans the QR code
7. Payment and Transaction preview is displayed to the payer bearing the amount and other relevant information.
8. The payer selects payment method
9. The system prompts for payer's authentication
10. Payer enters pin
11. The financial institution requests for payer's authentication
12. Payer authenticates with financial institution
13. Transfer of financial value
14. Real-time transaction notifications are sent to all entities involved.

VI. Experimentation and Results

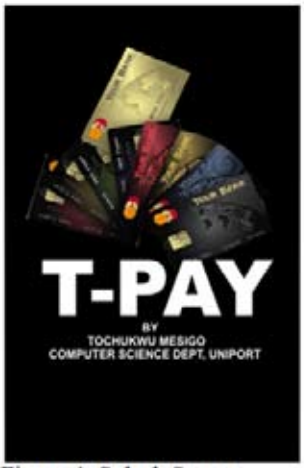

Figure 4: Splash Screen

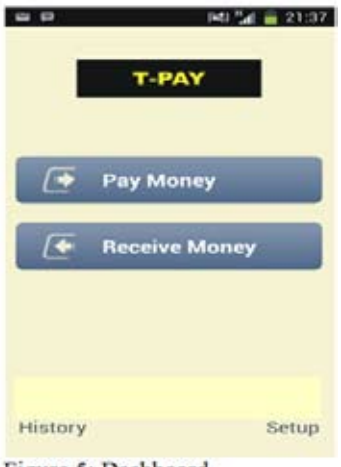

Figure 5: Dashboard

Figure 6: Input Amount

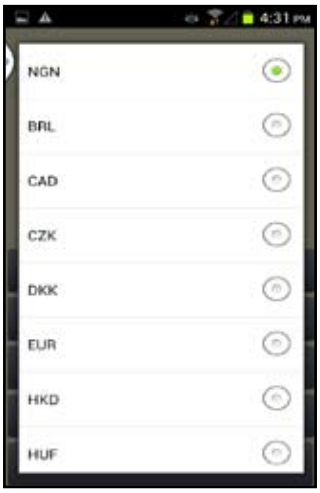

Figure 7: Currency List

Figure 8: Generating QR Code


Figure 9: QR Code


Figure 10: Scanning QR Code

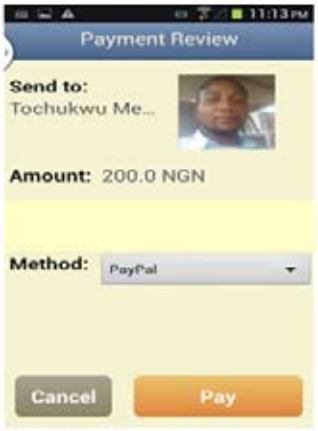

Figure11: Payment Preview

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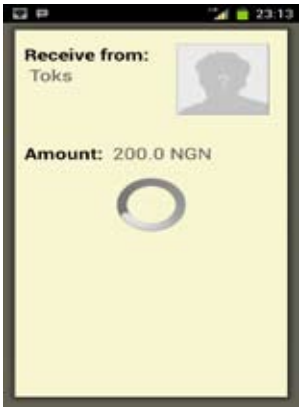

Figure 12: Receiver's Waiting Screen

Figure 13: Service Provider's Authentication

Figure 14:Paypal Authentication

Figure 15: Login Successful

Figure 16: Settling Payment

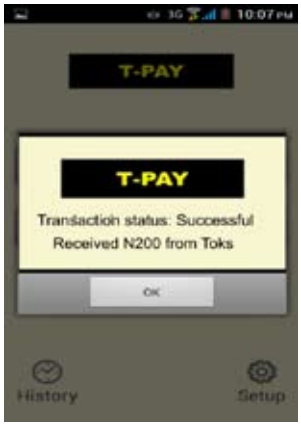

Figure 17: Notification

VII. Discussion of Results

Once the application is launched, the splash screen activity as shown in Fig. 4 will be launched and stay for three seconds and then the dashboard activity as shown in Fig. 5 will replace it for a configured account or the registration process will start for an account to be configured on the phone. The account registration involves the input of account name, email, phone number, country, pin, profile picture and other personal details. After registration, a money/banking account is needed in order to perform financial transactions successfully. This money account can be a paypal account or a credit card. A user can add multiple credit cards or paypal accounts and these details will be stored in the cloud. For a transaction to occur, the receiver or merchant will launch the application, and then from the dashboard he enters the amount of money expected to be received as shown in Fig. 6 and choose a corresponding currency from the list of currencies in Fig. 7, then the mobile payment system will generate a QR code equivalent bearing his account and transaction details in an encoded format as shown in Fig. 8 and 9. The receiver now shows the payer the barcode to scan and the sender/payer now scans the barcode using his own mobile phone to get the transaction information required to complete the payment as shown in Fig. 10. Once the barcode is successfully scanned and decoded, the transaction details or payment preview as shown in Fig.11 is displayed to the payer with options to select which bank account or credit card to use and complete the payment. The customer then selects an account, enters his pin for the mobile application authentication as shown in Fig.13, and then is transferred to the financial institution's platform for the second authentication as shown in Fig. 14 before checkout. Once checkout is completed, the transaction notifications will be sent instantly and the transfer of financial value will also be real-time as shown in Fig. 17.

VIII. Conclusion

As a result of this study, we developed an Android based mobile payment system which can serve as an alternative to physical wallet by enabling users to transfer financial value between peers. The system makes use of the Quick Response codes technology as a means of encryption and communication between the sender and the receiver. The system was found to be more secure due to better authentication scheme enforced by different entities, eliminates the need for agents in the payment ecosystem, does not require sharing of personal details as sharing of personal details is handled by the QR code, and satisfies the universal property.

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