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Abstract. The Nigerian economy is still largely cash based arising from inadequate infrastructure, trust and instability in the banking sector. However, there are improvements in the adoption of the electronic platform through the concerted efforts of government by introducing some policies that encourage its use. The recent policy is the cashless policy, which is aimed at reducing the use of cash to the barest minimum. This paper is aimed at developing an electronic payment system that integrates all the bank accounts of a particular holder together and access granted to them with or without a payment card through a multi-factor authentication procedures such as pin, fingerprint, irish or 3D facial recognition. On a full implementation, this system incorporates additional security protocol on the device to avoid nonrepudiation and ensure that the user is actually who he claims to be. The system will enhance ease of use as well as simplify the use of the e-Payment channels.
Keywords - e-Payment, Fingerprint, Authentication, ATM, ICT, Mobile phones, and Cardless

1. Introduction

The Nigerian banking sector had undergone several evolutions ranging from Bank Consolidation policy, Cashless Policy to the most recent, which is the Biometric Verification Number (BVN) policy.

The consolidation policy brought about a reduction in the total number of banks from 89 to 25 healthy, vibrant and trusted banks [1, 2]. This exercise led to massive adoption of ICT for efficient service delivery within the banking sector in Nigeria. Prior to this, the economy was largely cash-based with over 90% of funds residing outside the banking sector as against 4% and 9% reported in the UK and US respectively [3, 4].

Similarly, that cashless policy was instituted to discourage high usage of cash across the economy, reduce cash payments and encourage more electronic-based transactions (payments for goods, services, transfers, etc.) [5].Furthermore, in other to reduce fraud and corruption in the society, the Central Bank of Nigeria introduce the Biometric Verification Number, which requires each bank customer to have a single identity within the Nigerian banking system regardless of the number of accounts owned. The system is to complement the existing means of identification of customers, which include: the driver's license; the International Passport; the National Identity Card; and the Permanent Voter's Card [6, 14].

Arising from these policies, there are tremendous improvements in the adoption of the e-Payment platforms. For instance, table 1 shows volume of non-cash transactions within the banking sector in Nigeria across the various payment instruments including Cheques, NIBSS Electronic Fund Transfer (NEFT), NIBSS Instant Payment (NIP); and Electronic platforms, which include ATM, POS, Web (Internet), and Mobile money (MMO) [7, 14].

Table 1: Volume of e-Payment Channels from 2012 to 2016. Source: [7]

	Cheques	NEFT	ATM	POS	WEB	MMO	NIP

2012	12,161,694	28,941,559	375,513,154	2,587,595	2,276,464	2,297,688	4,449,654
2013	14,211,078	29,834,317	295,416,724	9,418,427	2,900,473	15,930,181	17,112,158
2014	15,283,933	29,690,765	400,269,140	20,817,423	5,567,436	27,744,797	40,829,854
2015	13,466,461	28,935,605	433,695,748	33,720,933	7,981,361	43,933,362	71,223,545
2016	11,719,847	29,754,182	590,238,934	63,715,203	14,088,247	47,053,252	153,616,450

It is evident that the use of the electronic channels – ATM, PoS, Web and MMO are on the increase but cash is still dominant but reduced compared to the previous era. The enormous benefits of e-Payment notwithstanding, there are infrastructural challenges that must be resolved to create an enabling environment for its implementation. Some of the measures taken by the Central Bank as listed by [8] include:

- All ATMs across the state must be configured to accept any card irrespective of the issuing firm.
- All PoS terminals must accept payments through all cards – Visa, Mastercard, Verve, Genesis etc.
- Provision of more service channels (ATM and PoS).
- Provision of Electricity and ICT infrastructure.
- Provision of improved Quality of Service (QoS):
  - Broadband infrastructure
  - Human capacity building
  - Credible legal framework and security

The above policies have sanitized the economy to a certain extent as the adoption of the e-Payment platform is on the increase and individual accounts are being linked together. Fraudulent individuals have to forfeit their savings as they refused to show up for the BVN exercise. They have since resorted to burying millions of dollars at homes, farms and septic tanks rather than depositing with the banks. This study therefore targets at remodeling ATM operations to accommodate in a single transaction access to the various accounts with or without a card and authenticated through a combination of pin, fingerprint, irish and or 3-D facial recognition.

2. Review of Related Works

Overtime, the researchers have evolved a number of systems that are aimed improving the adoption of the electronic payment platforms as canvased by the Nigerian government. Some of the previous papers include [9] that proposed an e-payment architecture for Nigeria taking into consideration the precarious situations. The system, as against the general practice proposed the integration of the national data bank, the stake holders/clearing networks and the switching companies for authentication of customers with a view to curbing the level of fraud perpetrated in the sector.

Similarly, [10] designed a framework for a unified electronic identity system for Nigeria. The project designed a single means of identification for all platforms of business transactions (voter's card, driver's license, national ID, and banking). This is against the multiplicity of cards carried by an individual. [11] also designed a secure unified e-payment system for Nigeria. The project involved the use of national databanks for banks and the use of a single card for both business and non-business transactions. The project proposed that each bank be coded and the code used for banking transactions. The project brought about a reduction in the number of ATM cards carried by an individual and that a single card could be used for all bank transactions.

Citibank was reported to be testing an ATM without screen or keypad. The system works based on proximity with smartphone and iris scan to authenticate customers. It was developed by Diebold and it employs

near field communication (NFC) to identify customers through their phones [12, 16]. Similarly, [13] developed in conjunction with Hyosung a Japanese company a fingerprint biometric ATMs which incorporate biometric authentication alongside a raft of other security features. These machines are being deployed by some banks.

The current research is an improvement on the latter. The BVN policy has brought about a unique identification for all customers by linking all bank accounts together. This eliminates the use of codes to represent the banks as reported in [11, 17]. Thus, we can take advantage of this to remodel the ATM operations with or without a card to carryout transactions on any account from any bank in a single operation through a multi-factor authentication system.

3. Design and Considerations

The proposed system would add new features to the machine to ensure security and easy maneuverability for the customers. The uniqueness of this approach is that cards are not required to perform any transaction but may be used optionally, when one of the factors of authentication is wrong or not available.

Another one is the introduction of fingerprint recognition devices to the machine [18, 19]. Although this is present in some ATM's across Nigeria (United Bank of Africa and some others) the feature is not currently active nor utilized to fully ensure security measures to eliminate deceitful acts. The idea of adding this would be to introduce an extra security protocol on the device to ensure the user is who he claims to be. The proposed design is peculiar to Nigeria because the use of BVN has not been reported in literature as a consideration for the design of ATM. Similarly, by international standard, each account is associated with a particular card but we have demonstrated the possibility of a cardless transaction.

From figure 1, the correct entry of both pin and fingerprint will grant access to bank transactions otherwise iris and/or card may be required before transaction is canceled or terminated.

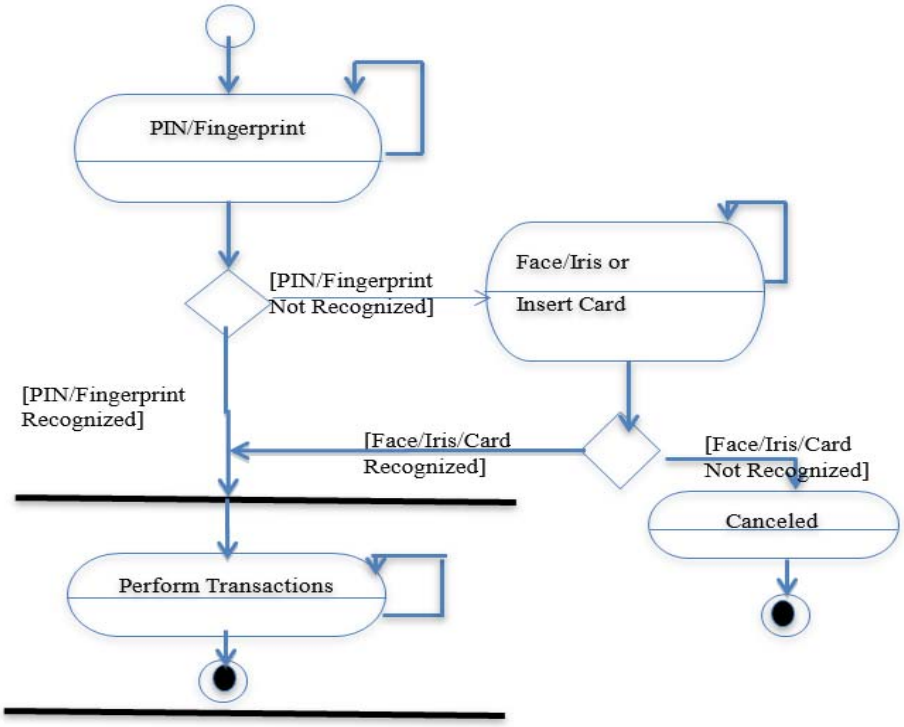

Figure 1: Activity Diagram for the Proposed System

Similarly, figures 2 and 3 show the authentication screen and transaction screens respectively.

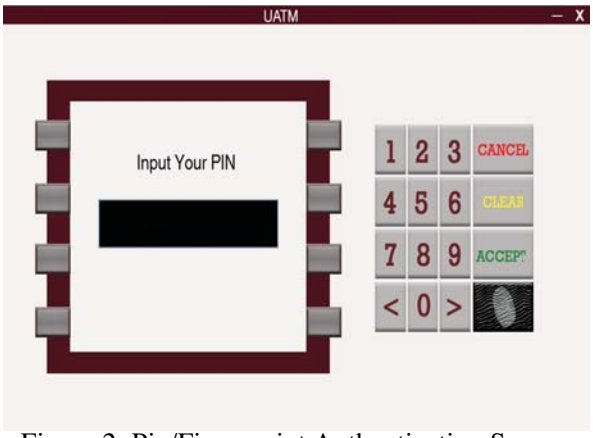

Figure 2: Pin/Fingerprint Authentication Screen

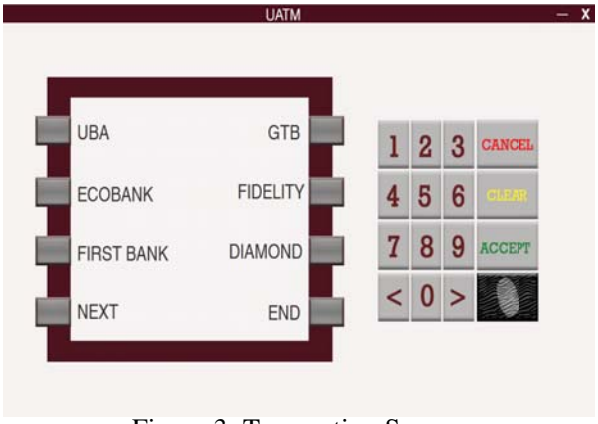

Figure 3: Transaction Screen

4. Conclusion

This paper reports the prototype of a multi-factor authentication ATM system that does not require the use of card except in a scenario where one of the factors of authentication is not available. The system offers ease of use and simplifies the use of the platform with the intention of encouraging financial inclusion in the country.

The introduction of the BVN is unique to Nigeria where all the bank accounts are linked together. Thus, there is need to reduce the cost of producing cards as well as the risk of carrying them all around. This system represents the future of ATM transactions as reported in the related works.

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