Enhancing automated teller machine with multi-lingual and multi-denominational software functionalities

Boluwaji A. Akinnuwesi*

Department of Information Technology,
Bells University of Technology,
P.M.B. 1015, Ota, Ogun State, Nigeria
E-mail: boluakinnuwesi@bellsuniversity.edu.ng
*Corresponding author

Faith-Michael E. Uzoka

Department of Computer Science and Information Systems,
Mount Royal University,
Calgary, Alberta, T3E6K6 Canada
E-mail: fuzoka@mtroyal.ca

Adetoba P. Obasa

Department of Computer Science and Technology,
Bells University of Technology,
P.M.B. 1015, Ota, Ogun State, Nigeria
E-mail: tobaobasa@yahoo.com

Abstract: In this study, we conceptualise a multi-lingual and multi-denominational software for automated teller machine (ATM). The purpose is to model an ATM that communicates in different pre-defined languages and dispenses cash in different denominations based on the customers' choices, thereby enhancing the ease of use by customers and reducing frustrations by rural dwellers. The architecture of the system was developed using the unified modelling language, whereas the prototype was developed using Java programming language for the front-end, and Oracle database management system as the back-end. The prototype was tested using some hypothetical data and was found to successfully mimic ATM transactions in the local Nigerian languages. The results of the study also point to an improvement in the user interface with icons and music being more friendly and welcoming to the local populace.

Keywords: ATM; automated teller machine; currency denomination; multi lingual; multi denomination; bank; cash; software system; customer; user friendly; e-finance.

Reference to this paper should be made as follows: Akinnuwesi, B.A., Uzoka, F-M.E. and Obasa, A.P. (2013) 'Enhancing automated teller machine with multi-lingual and multi-denominational software functionalities', *Int. J. Electronic Finance*, Vol. 7, No. 2, pp.97–114.

Biographical notes: Boluwaji A. Akinnuwesi is a faculty in the Department of Information Technology, Bells University of Technology, Nigeria. He obtained his BSc in 1998, MSc in 2003 and PhD in 2011, all in Computer Science with focus on software engineering and application. He is a Senior Lecturer and the Director of the University Computer Centre. He was a Visiting Research Scholar at ICITD, Southern University, Baton Rouge, Louisiana in 2010. He has published in journals and conferences. His research interests are system performance evaluation using soft-computing techniques, user involvement and organisational issues in system development, expert system and software engineering.

Faith-Michael E. Uzoka is an Associate Professor in the Department of Computer Science and Information Systems, Mount Royal University, Canada. He obtained his MBA (1995), MS (1998) and PhD (2003) in Computer Science with focus on information systems. He also conducted a two-year post doctoral research in the University of Calgary (2004–2005). He is on the editorial/review board of a number of information systems and medical informatics journals/conferences. His research interests are medical decision support systems, multi-criteria decision analysis, technology adoption and innovation, IT personnel research and IT education research. He is the President of the Canadian Institute for Medical and Organizational Informatics.

Adetoba P. Obasa obtained his BTech in Computer Science in 2012. He is presently serving as a youth corps member under the National Youth Service scheme in Oyo State in Nigeria. He is an application programmer and his areas of interest are system analysis and design, software development and database system.

1 Introduction

An automated teller machine (ATM) is a device that enables banks' customers to process account transactions in a public space without the need for a human cashier or bank teller. It involves a user inserting into an ATM a debit or credit card that is encoded with information on a magnetic strip. The strip contains an identification code that is transmitted to the bank's central server. Authentication is provided by the customer by typing a Personal Identification Number (PIN). The computer software then permits the ATM to complete the transaction. Most of the machines can dispense cash, accept deposit, transfer funds and provide information on account balances. In Nigeria for example, with the help of organisations such as inter-switch, e-transact and so on, banks have been interoperating nationwide so that customers can access cash using ATM of any bank.

According to the ATM Industry Association (ATMIA), the number of ATMs worldwide in use was estimated to be 2,249,497 as at the end of 2010 and it was estimated to be 3,195,880 at the end of 2016 (ATM Industry Association, 2012). ATM installations are of two types, namely on-premise and off-premise. On-premise ATMs are more advanced and multi-functional machines that complement the capabilities of a bank's branch, and they are more expensive. Off-premise machines are deployed by financial institutions and independent sales organisations where there is a need for cash; they are cheaper and mostly mono-functional.

An ATM is made up of the following devices: CPU (to control the user interface and transaction devices), magnetic/chip card reader (to identify the customer debit/credit card), key pad, secure crypto-processor (generally within a secured enclosure), visual display unit, function keys buttons (usually close to the display), touchscreen (used to select various aspects of the transaction), printer, vault, housing (for aesthetics and to attach signage to).

A multi-lingual and multi-denominational software system for ATM is a presentation of an ATM in multiple languages and currency denomination of choice. It will provide customers with the opportunity of selecting the language they best understand in performing their transactions and in also choosing any denomination required for their money. This is unlike the existing ATMs that could communicate mostly in English language and has fixed denomination type (e.g., in Nigeria the denomination available in an ATM at a time is one thousand naira (₦1000) or five hundred naira (₦500) currency notes). Though there are 5 naira, 10 naira, 20 naira, 50 naira, 100 naira and 200 naira currency notes in circulation, these notes are not available in any of the ATMs in Nigeria. The prototype developed in this work takes into consideration the diverse levels of literacy and financial needs of customers. The following user interface characteristics are enhanced to better meet user needs: ease of use, ability to make choices and ease of communication. Some of these are not extensively considered in the current ATM systems. Thus the proposed system addresses the following that were observed as the limitations of the present ATMs:

- *Language differences*: Language differences are not considered in the present ATM applications. For example, the ATM provides interaction only in the English language which makes it difficult for non-English speakers who are mostly literate in their native languages to interact and use the ATM.
- *Level of human computer interaction*: Present ATMs provide a limited level of interactivity. The ATM is meant to guide the customer throughout his or her period of use. For example, when the ATM has a problem with a customer's debit/credit card, it alerts the customer about the error which had occurred and directs him or her to the appropriate helpdesk for rectification.
- *Currency denominational choices*: Present ATMs dispense only a limited range of denominations within a transaction. Using Nigeria as a case study, the ATMs in Nigeria dispense either ₦500 or ₦1000 notes, thereby giving no room for customers to choose the denomination they want to withdraw. Withdrawing amounts not involving the ₦500 notes becomes challenging to customers.

This study was born out of regular experience of frustration expressed by rural dwellers in Nigeria while using ATMs. One of the key problems with the currently designed ATMs is that a wide spectrum of users were not involved in determining the user requirements of ATMs. The key persons who determined the user requirements were bank staff (Batiz-Lazo and Reid, 2011). Therefore, a review of the literature shows the need for multi-lingual and multi-denomination ATMs. This study provides a conceptualisation, which is a first step in the actualisation of a user friendly ATM for rural dwellers in Africa and other developing regions of the world. The rest of the paper is organised as follows: Related works are presented in Section 2. The conceptual design of the proposed multi-lingual and multi-denominational ATM software system is

presented in Section 3. System implementation is presented in Section 4 and some concluding remarks are made in Section 5.

2 Related works

Automated transaction technology (ATT) is an emerging technology that supports online and real-time business transactions locally and globally. ATM is one of the products of ATT. ATMs are artificial machines that run online banking applications and thus render outdoor banking services to customers. In Taohai et al. (2010), the following ATM usability criteria were identified: effectiveness, efficiency, satisfaction and error. These criteria were evaluated against occupation categories. The results indicate that agriculturists (most of whom are rural dwellers) had the least amount of satisfaction with ATMs. It is worth noting that *innovation, ease of use, performance and effort expectancies* are key issues in technology development, adoption and usage (Davis, 1989; Venkatesh et al., 2003). Addition of *multi-linguality and mult-denominationality* features to the current ATM technology would likely enhance the functionalities and robustness of the machine, and thus provide services to users with minimal stress. It was indicated in Fong et al. (2010) that more vulnerable segments of the society (e.g., the elderly, the less educated and persons with disabilities) tend to have a high level of dissatisfaction with the functionalities that current ATMs present. The authors simulated a virtual reality environment for ATMs in order to assist persons with some forms of disability in improving the ease of use of ATMs. In Chan et al. (2009), a modification to the features of the ATM was proposed in order to help older adults, and less educated in the use of ATMs.

A number of authors have proposed multi-lingual systems as a means of increasing the ease of use, performance and effort expectancies of users. In Turunen et al. (2004), an AthosMail was presented, which is a multi-lingual adaptive spoken dialogue system for the email domain. It is used for reading email messages. Adaptivity and the integration of different approaches for verbal interaction are the key features of the application. The application is made up of a flexible system structure that supports multiple components that have different purposes. The AthosMail system is made up of different components. Some of these components are for input interpretation, dialogue management, output generation, user modelling and text processing. The main objective of the application is the accessing of mail boxes using a standard mobile or desktop phone by users. This application is based on the existing mailman application (Turunen and Hakulinen, 2000b). The AthosMail consists of two parts and it is the actual dialogue system that the users interact with. It has the functionality of both speech input (speech recognition) and dual tone multi-frequency or touchstone interfaces. The AthosMail system is constructed by adopting Jaspis architecture (Turunen and Hakulinen, 2000a, 2003), which supports distributed and coordinated components, shared system knowledge and system-level adaptation.

A multi-lingual Question and Answering (QA) system was developed in Cruchet et al. (2005). The system was applied in trusted health information. The system used a supervised method to group questions according to its medical type and its type of expected answer. French and English were the first languages added. Italian languages were added thereafter. The QA system is intended for both patients and health professionals, and was made available in English, French and in Italian. The medical

types and the types of expected answers have been defined with the classification of French and English questions. In Olaniyi et al. (2011), the authors presented a framework of multi-lingual voting system for developing nations using Nigeria as a case study. The system according to the authors is to provide a credible voting system in Yoruba, Hausa, Igbo and the English language; thus providing different platforms for voters to express their opinions in the election process, and to provide a reliable measure to track the results of elections right from the point of voting.

In 2010, multi-denominational banknote dispenser also called the Multi-Denomination Dispensing Mechanism (MDDM) by Talaris was introduced. It is a mechanism that is friction fed in a horizontal configuration. It is a dispenser built for full function ATMs and other self-service applications. The MDDM is a mechanism that gives room for flexible mechanical integration and has a cassette capacity of up to 2000 notes. The mechanism has the ability to dispense one to six denominations. It has cassettes that are built to withstand tampering and it also has the ability to deliver notes in bundles. The mechanism's loading frame is used for convenience and to correct loading of banknotes into the feed cassettes. The electronically locked cassettes can only be opened with the loading frame, thereby providing a high degree of security. Also in 2012, Talaris launched over 100,000 bill dispensing mechanisms to the Triton systems at ATMIA US Conference 2012 (Casino Enterprise Management, 2012).

Multi-lingual systems provide information access, which enhances the acquisition, dissemination, exchange and understanding of knowledge in the multi-cultural, multi-ethnic and multi-language society. Robustness and adaptivity are also supported (Mikko et al., 2004a). In Mikko et al. (2004b), a service quality evaluation method (i.e., SERVQUAL) was developed for evaluating spoken dialogue system. In Walker et al. (2003), a universal phone recogniser system for conversational telephone-quality speech was developed. The recogniser was trained with a variety of language data which thus enables it to recognise most of the world's major phonemic categories. In Caballero et al. (2004), a data-driven approach was developed and it was based on a decision tree algorithm, which clusters contextual units of different dialects. This approach helps to determine a multi-dialectal phone set for an automatic speech recognition system for Spanish dialects.

An ATM uses several technologies to ensure authentication, secrecy and security. These include encryption (the scrambling of information in data transmissions to provide confidentiality) and electronic signatures (methods that use techniques as passwords, PINs, smart cards and biometrics) to verify the identity of the customer and provide data integrity. Other computer security technologies, such as firewall, antivirus programs and intrusion detection systems are also used. Modern ATM physical security concentrates on denying the use of the money inside the machine by unauthorised customers, by using different types of intelligent banknote neutralisation systems. ATMs are connected to interbank networks, enabling customers to withdraw and deposit cash from machines that do not belong to the bank where they have their account or in the country where their accounts are domiciled (enabling cash withdrawals in local currency). Some examples of interbank networks are PULSE, inter-switch, STAR, LINK and many more. Many banks charge a small fee for ATM usage, this fee is meant for users who are not customers of the bank where the ATM is located.

Presently Nigeria is composed of more than 250 ethnic tribes with language and cultural diversity. The three largest and most dominant ethnic groups are the Hausa, Yoruba and Igbo. Other smaller groups include the Fulani, Ijaw, Kanuri, Ibibio, Tiv and

Edo. These ethnic groups have separate and independent histories, diverse cultures and languages. The official language is English. However, a small minority of the country's population do not understand English. Furthermore, Nigerians prefer to communicate in the traditional languages or in one of the three dominant languages. Language and cultural diversity is not peculiar to Nigeria. There is diversity of languages and cultures in many countries around the globe. This is a pertinent contextual issue that should be taken cognisance of during technology development in order to facilitate the adoption and good usage of any technology.

The following are the deductions established from the literature reviewed and they form the basis of the system proposed in this paper:

- there are multi-lingual technologies that exist and are being used in systems such as voting and mailing system; but multi-lingual technologies are yet to be deployed to ATMs (especially in developing countries that need them)
- though there are few ATMs in some countries that can dispense cash in two or more denominations in one withdrawal, in most cases the customers cannot make a choice of the denomination they actually prefer on the machine
- there is the need for ATMs that have both multi-linguality and multi-denominationality functions.

3 Conceptualisation of the multi-lingual and multi-denominational ATM software system

A multi-lingual and multi-denominational system for ATM is proposed in this work. The system has two main users: the customers and the bank administrator. The following sub-sections describe the architecture, data and transaction models of the system.

3.1 Proposed system architecture

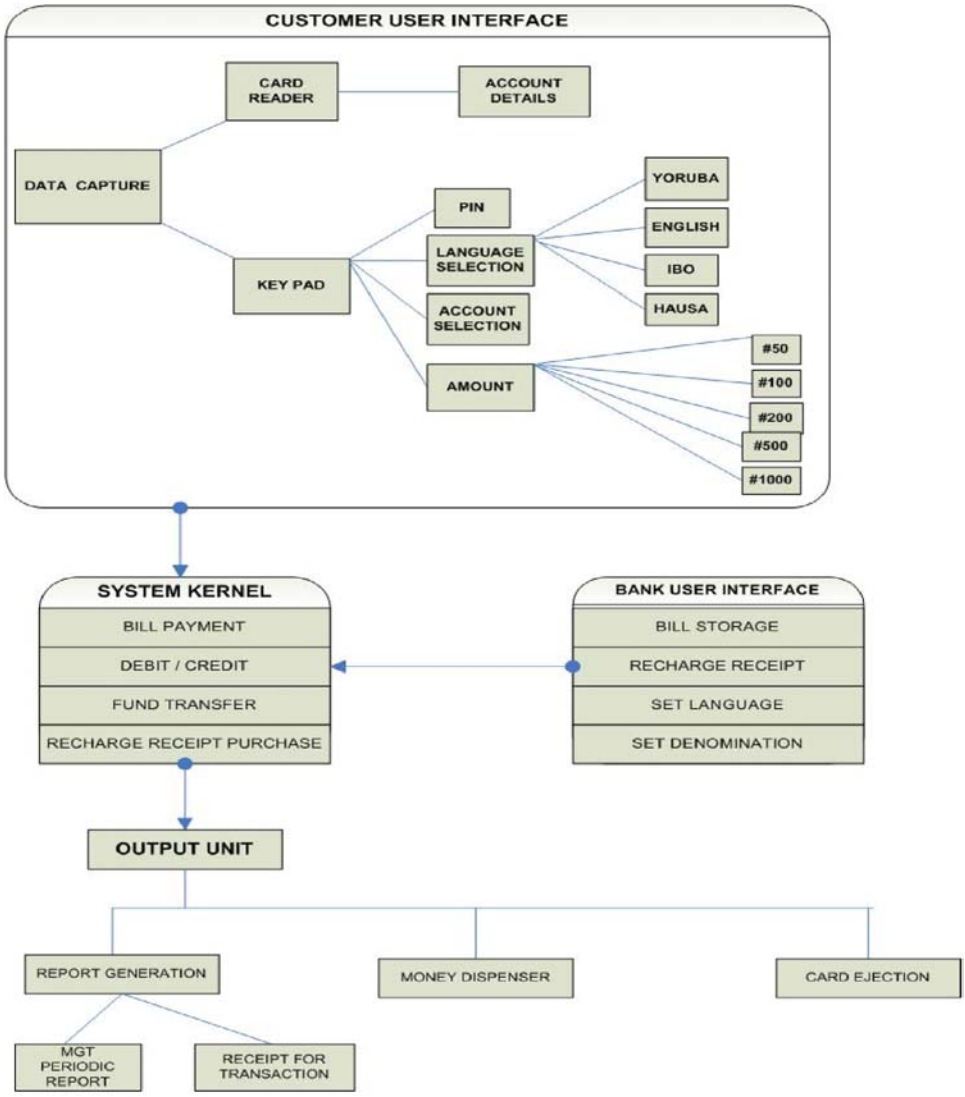
The system is modelled using unified modelling language. Figure 1 presents the system architecture. The software architecture adopted is client-server architecture which enables large number of users to operate the system from different remote stations. The architecture is divided into three sub-systems: the user interface, the system kernel and the output unit.

The user interface subsystem: This sub-system is divided into two: customer user interface and bank user interface. The customers' user interface is an interface by which customers are able to view their account details, enter their pin codes, choose amount, select the type of account they want (current, savings, etc.) and select their most preferred language and denomination; whereas the bank user interface allows authorised bank officials to store bills, load transaction receipt paper, set languages and set denominations and other administrative functions electronically.

The system kernel sub-system: This is the sub-system by which all financial transactions are done. The transactions carried out are as follows: bills payment processing, debit/credit transaction and purchase of telephone voucher, etc.

The output unit sub-system: This is the sub-system by which all reports on customers' transactions are generated and printed for management decisions or further processing by management of the bank.

Figure 1 System architecture of the multi-lingual and multi-denominational ATM software system (see online version for colours)



3.2 Data and transaction models

Relational database modelling technology is adopted for the design of the conceptual database objects envisaged for the system. A relation is similar to a table consisting of columns and rows. The general form of the relation is given by:

$$R[A_1, A_2, \ldots A_k, A_{k+1}, \ldots, A_{n-1}, A_n].$$

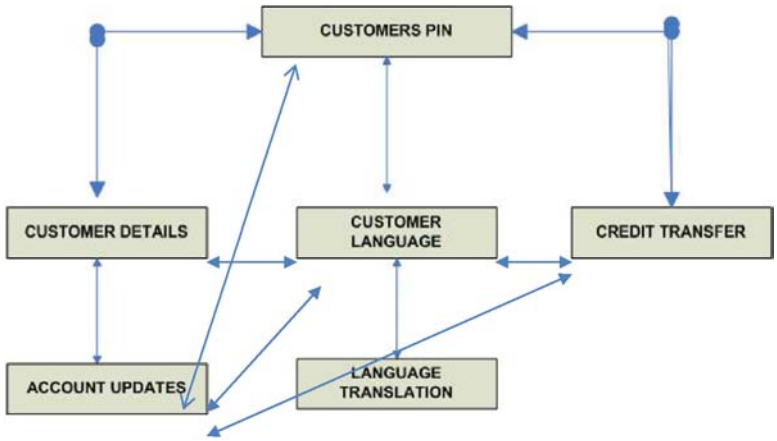
The name of the relation is denoted by R, the set $\{A_i\}$, $i = 1, 2 \ldots n$, represents the attributes of the relation R (Cannolly and Begg, 2002).

The relations below are the core relations identified for the ATM system:

- customer PIN [Pin – number, customer account number, card number]
- customer details [customer account number, customer name, customer surname, customer address]
- account updates [customer account number, account credit, account debit, account balance, date stamp, time stamp]
- customer language [customer account number, language name]
- credit/debit transfer [customer account number, phone number, credit/debit value, date stamp, time stamp]
- customer denomination [customer account number, currency denomination].

The logical diagram of the interrelationship between the relations is presented in Figure 2.

Figure 2 Logical diagram of the inter-relationship between the relations in the database model (see online version for colours)



3.3 Query transactions list

The following is a list of query transactions supported by the proposed ATM system:

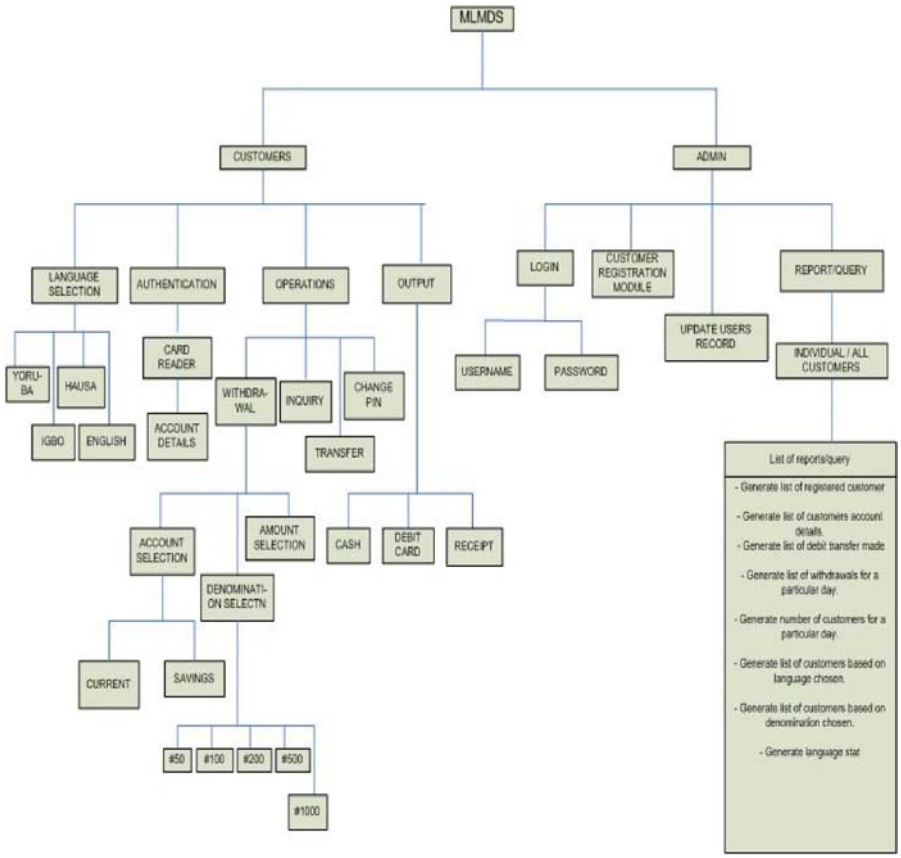
- Get customers pin
- Get customer account detail
- List customer account details
- List all languages available
- List customers account updates
- List credit transfer(s) made

- List debit transfer(s) made
- Get number of withdrawals for a particular day
- Get the number of customers for a particular day
- List customers based on the language chosen
- List customers based on the denomination chosen.

4 System implementation

The prototype is composed of the following interfaces: welcome interface, language selection interface, authentication interface, operation selection interface, account selection interface, denomination selection interface, amount selection interface, administrator login interface, registration interface, set language/music interface, administrative interface, update user's record interface, view all customers details interface, view individual details interface, view denomination chosen interface (individual, all), view amount debited interface. The implementation hierarchy is presented in Figure 3.

Figure 3 Implementation hierarchy (see online version for colours)

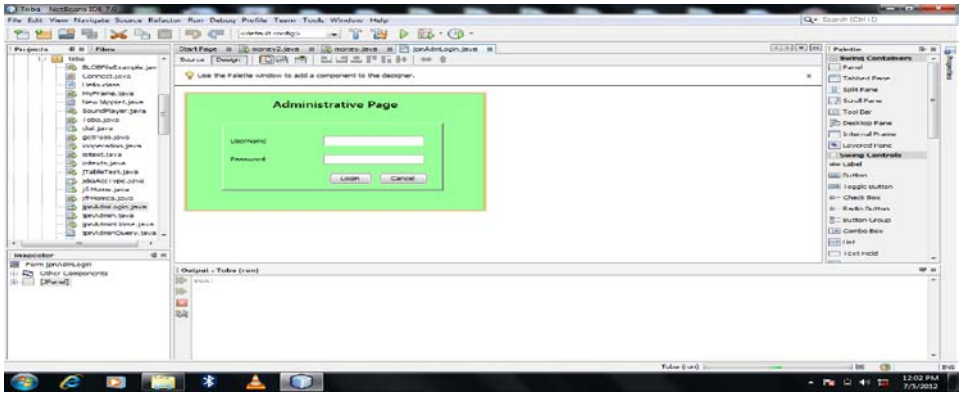


4.1 Bank administrative interfaces

The bank administrative interfaces are the interfaces by which the bank administrative staff operates the system. The staff carries out the following tasks through the interface:

System login: The administrator types in his or her username and password to gain access to the system. The screenshot is presented in Figure 4.

Figure 4 Administrator login interface (see online version for colours)



Registration of customers: The administrator captures the customer's details and picture. A screenshot is presented in Figure 5.

Figure 5 Registration interface

Setting languages and music: The administrator activates and deactivates languages and music. A screenshot is presented in Figure 6.

Querying: The administrator queries customers' details (individual, group or all), language details, denomination chosen, and financial transactions on the system.

Update users' record: The administrator makes necessary authorised changes in the customers' record and updates the database. The administrator can also search for a particular record in the database.

Figure 6 Set language/music interface

4.2 Customers interactive interfaces

These are the interfaces whereby customers interact with the system. The customers do the following using the interfaces: language selection; PIN authentication; selection of required bank service (e.g., change PIN, cash withdrawal, fund transfer, account balance enquiry); selection of account type (e.g., current or savings); selection of required amount of cash to withdraw or transfer; selection of required denomination.

A sample cash withdrawal transaction carried out with the system using *Yoruba language* is illustrated below.

> "The customer was welcome by a user friendly welcome interface with background music. The screenshot of the welcome interface is presented in Figure 7. It welcomes the prospective customers to the ATM system. Customer clicked 'Next' button to activate the ATM for operation and the language selection interface was displayed. On this interface, the machine speaks to the customer to select the language he or she wants to perform his or her transaction from the list of the languages available. The languages available are English, Yoruba, Igbo and Hausa. Figure 8 presents the screenshot of the language selection interface. The language selected for this illustration was *Yoruba language* and the ATM speaks with the customer in *Yoruba language* throughout the transaction process. Also the text contents in the interfaces are written in *Yoruba language* except for figures in some interfaces. After language selection, the customer typed his or her authorisation details on the authentication interface presented in Figure 9. This is the interface by which the customer types his or her PIN code (i.e., 'Kokoro Idanimo' in Yoruba language) in order to gain access to perform his or her transaction. The text contents in Figure 9 are in Yoruba language. After customer has been granted

access, the operation selection interface presented in Figure 10 was displayed. In this interface the customer selects the financial operation he or she wants to perform. The operations are: 'Paaro Kokoro Idanimo' (i.e., Change PIN); 'Igbowo Jade' (i.e., Cash Withdrawal); 'Fi Owo Ranse' (i.e., Fund Transfer) and 'Iwadi ni apo owo re' (i.e., Balance enquiry). In this case, 'Igbowo Jade' was selected and the account type selection interface presented in Figure 11 was displayed. This is the interface by which the customer selects the account he or she wants to withdraw from. After selecting an account type, the denomination selection interface presented in Figure 12 was displayed. At the denomination interface customers select the denomination he or she wants to withdraw in. Customer can choose to withdraw in ₦50, ₦100, ₦200, ₦500, ₦1000 notes. ₦100 denomination was chosen in this case. Thereafter amount selection interface presented in Figure 13 was displayed. It is the interface by which the customer selects or types the amount he or she wants to withdraw. In this scenario the amount typed was more than the balance in the account and thus the following message was displayed in Yoruba language: "E maa binu. Owo ti e ni ni apo ko to iye ti e bere fun, e mu iye owo ti o kere" (i.e., Sorry, there is insufficient fund, choose a smaller amount). The interface for notification for insufficient fund is presented in Figure 14."

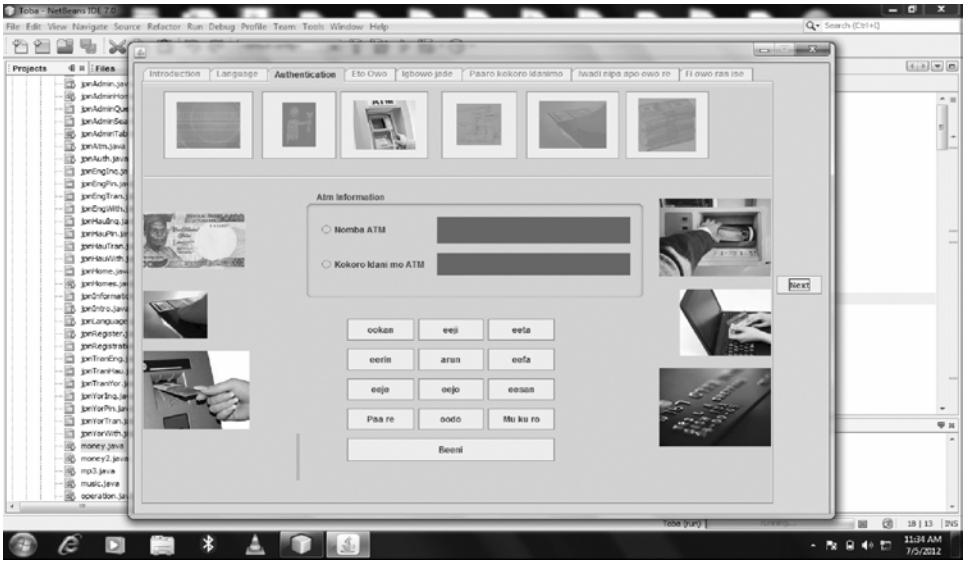
Figure 7 'Ikini Kaabo' (i.e., welcome interface)

This interface welcomes the prospective customers to the ATM system in all the languages that the bank administrator has set for the machine. In this prototype, the ATM welcomes the customers in English and in the three major local languages (Yoruba, Igbo and Hausa). For example, the greeting in Yoruba is as follows: "E Kaabo si ero ATM ti ile ifi owo paamo ti WEMA" (Yoruba language).

On this interface the machine speaks to the customer to select the language they want to perform their transaction, in the languages available. The languages available are English, Yoruba, Igbo and Hausa. The language selected for illustration was Yoruba language and based on this selection, all interaction was done in the Yoruba language. This is reflected in the subsequent interfaces.

Figure 8 Language selection interface

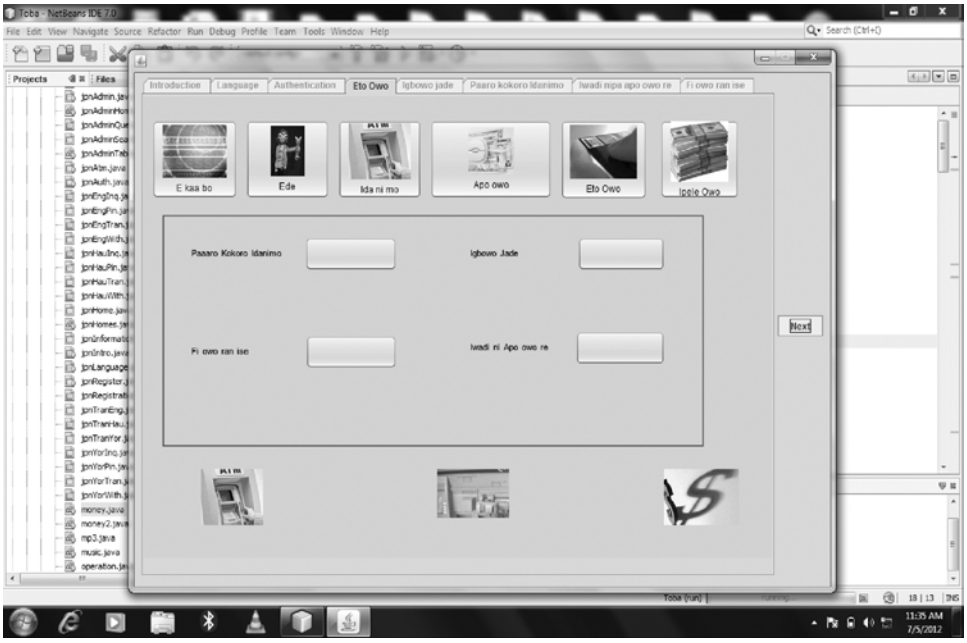
Figure 9 Authentication interface



This is the interface by which the customer types his or her PIN code in order to gain access to perform his or her transaction after choosing the language of his or her choice for communication. The interpretation of the text on the interface is as follows:

> '*Nomba ATM*' → *ATM PIN*; '*Kokoro idani mo ATM*' → *ATM card Number*; '*ookan*' → *1*; '*eeji*' → *2*; '*eeta*' → *3*; '*eerin*' → *4*; '*aarun*' → *5*; '*eefa*' → *6*; '*eeje*' → *7*; '*eejo*' → *8*; '*eesan*' → *9*; '*oodo*' → *0*; '*pare*' → *Erase*; '*mu ku ro*' → *Cancel*; '*beeni*' → *Ok*.

Figure 10 Operation selection interface



This is the interface that comes after the customer has gained access by typing his or her PIN. In this interface the customer selects the financial operation he or she wants to perform. The interpretation of the text on the interface is as follows:

'*Paaro kokoro idanimo*' → *Change PIN*; '*Igbowo jade*' → *Cash withdrawal*;
'*Fi owo ranse*' → *Fund transfer* and '*Iwadi ni apo owo re*' → *Balance enquiry*.

Figure 11 Account selection interface

This is the interface by which the customer selects the account he or she carries out the transaction. The accounts available are: *savings account and current account.*

This is the interface by which the customers select the denomination he or she wants to withdraw. They can choose to withdraw in ₦50, ₦100, ₦200, ₦500, ₦1000 notes.

Figure 12 Denomination selection interface

Figure 13 Amount selection interface

This is the interface that comes after the customer selects the denomination he or she wants. It is the interface by which the customer selects or types the amount he or she wants to withdraw.

After the customer has selected or typed in the amount he or she wants, the money is dispensed. If the amount in the customer's account is less than the amount he or she wants to withdraw, a notification is displayed, as shown in Figure 14. The message displayed is: *"E maa binu. Owo ti e ni ni apo ko to iye ti e bere fun, e mu iye owo ti o kere" (English language: Sorry, there is insufficient fund, choose a smaller amount).*

Figure 14 Notification for insufficient fund interface

5 Concluding remarks

Existing ATM systems have been designed in the developed world, which are largely mono-cultural and unilingual. In most developing countries (especially in Africa), there is a high level of multi-lingual transactions occasioned by low level of understanding of English or French languages, both of which are common languages by which ATMs transact. Having a system that could only communicate in English or French language will not enhance ease of use by non-English (or French)-speaking users. Moreover, restricting ATM to dispensing cash in only one or two denominations at a transaction diminishes the user flexibility of decision to withdraw exactly the amount needed at the given transaction. In view of this, the proposed system could facilitate communication in the language of the customer's choice and also enable cash withdrawal in denominations of the customer's choice. This is an improvement over the existing ATM systems. This system also utilises adequate multi-media components to enhance user friendliness.

The system conceptualised in this paper has positive managerial implications for banks and utility implications for users. Many developing countries are cash-based societies. Banks tend to generate less revenue in cash-based societies. As noted in Snellman and Viren (2006), the use of cash decreases deposits and lowers banks' interest income. If ATMs are user friendly, the propensity to use the ATM increases, and service charges for some forms of ATM activities would increase banks' revenues.

Majority of the rural dwellers in Africa are either petty traders or artisans, who make daily income. Such incomes are kept at home with the hope of spending it in the coming days. Security issues arise from keeping money at home, especially in developing countries where there could be break-ins and other forms of stealing especially in rural areas. A convenient and easy-to-use ATM system would propel more users towards saving and withdrawing cash via the ATMs as a means of securing their funds.

It is worthy of note that no matter the extent of friendly interactive components implemented in the ATM, there will still be a small percentage of people who will have difficulties in performing any transaction using the ATM. However, future works are suggested as follows:

- adding more languages
- enhancing the system to be easily modifiable to other languages in other countries.

It is noted that although the proposed prototype seems to work perfectly on a personal computer or laptop, real life implementation of such a system would greatly depend on the hardware support provided by existing ATMs. The multi-lingual component of the system can easily be implemented since it would not require major hardware upgrades to existing ATMs. However, in order to fully implement the multi-denomination component, cash dispensers (trays) of existing ATMs would have to be enhanced to accommodate multi-denominational transactions.

Acknowledgements

The authors acknowledge the assistance received from some officials of various banks in Nigeria for providing some of the information needed for successful completion of this paper. Also, we acknowledge the efforts of the reviewers of this paper whose constructive reviews helped in refining the final output.

References

ATM Industry Association (2012) *ATM Worldwide*. Available @ https://www.atmia.com/regions/atm-s-worldwide/, Access date: November 6, 2012.

Batiz-Lazo, B. and Reid, R.J.K. (2011) 'The development of cash-dispensing technology in the UK', *IEEE Annals of the History of Computing*, Vol. 33, No. 3, pp.32–45.

Caballero, M., Moreno, A. and Nogueiras, A. (2004) 'Data driven multidialectal phone set for Spanish dialects', *Proceedings of 8th International Conference on Spoken Language Processing ICSLP 2004*, October, Jeju Island, Korea.

Cannolly, T. and Begg, C. (2002) *Database System: A Practical Approach to Design, Implementation and Management*, 3rd ed., Publication of Pearson Education Limited, Addison Wesley, Edinburgh Gate, Harlow, Essex CM20 2JE.

Casino Enterprise Management (2012) 'Talaris celebrates the supply of over 100,000 bill dispensing mechanisms to Triton Systems at ATMIA US Conference 2012', *ACEME Newswire*, Available @ http://www.casinoenterprisemanagement.com/newswire/talaris-celebrates-supply-over-100000-bill-dispensing-mechanisms-triton-systems-atmia-us-co, Access date: November 5, 2012.

Chan, B.C.H., Wong, A.W.K., Lee, T.M.C. and Chi, I. (2009) 'Modified automatic teller machine prototype for older adults: a case study of participative approach to inclusive design', *Applied Ergonomics*, Vol. 40, pp.151–160.

Cruchet, S., Gaudinat, A., Boyer, C. and Morandi, A. (2005) *Multilingual Question/Answering System Applied to Trusted Health Information*, Available at: http://www.hon.ch/Conf/Docs/scruchetQAMIE_v3.pdf, Access date: 24 December, 2012.

Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use and user acceptance of information technology', *MIS Quarterly*, Vol. 13, No. 3, pp.319–339.

Fong, K.N.K., Chow, K.Y.Y., Chan, B.C.H., Lam, K.C.K., Lee, J.C.K., Li, T.Y.H., Yan, E.W.H. and Wong, A.T.Y. (2010) 'Usability of a virtual reality environment simulating an automated teller machine for assessing and training persons with acquired brain injury', *Journal of Neuroengineering and Rehabilitation*, Vol. 7, No. 19, pp.1–9.

Mikko, H., Esa-pekka, S. and Markku, T. (2004a) 'Robust and adaptive architecture for multilingual spoken dialogue systems', *Proceedings of the Eighth International Conference on Spoken Language Processing (INTERSPEECH 2004-ICSLP)*, Jeju Island, Korea.

Mikko, H., Esa-pekka, S. and Markku, T. (2004b) 'Subjective evaluation of spoken dialogue systems using SERVQUAL', *Proceedings of the Eighth International Conference on Spoken Language Processing (INTERSPEECH 2004-ICSLP)*, Jeju Island, Korea.

Olaniyi, O.M., Adewumi, D.O., Oluwatosin, E.A., Arulogun, O.T. and Bashorun M.A. (2011) 'Framework for multilingual mobile e-voting service infrastructure for democratic governance', *Afr. J. of Comp & ICTs*, Vol. 4, No. 3, Issue 2, pp.23–32.

Snellman, H. and Viren, M. (2006) *ATM Networks and Cash Usage*, Bank of Finland Research Discussion Papers, No. 21. Available at: http://www.suomenpankki.fi/en/julkaisut/tutkimukset/keskustelualoitteet/Documents/0621netti.pdf, Access Date: November 9, 2012.

Taohai, K., Phimltares, S. and Cooharojananone, N. (2010) 'Usability comparisons of seven main functions for automated teller machine (ATM) banking service of five banks in Thailand', *International Conference on Computational Science and Its Applications*, Japan, pp.176–182.

Turunen, M. and Hakulinen, J. (2000a) 'Jaspis – a framework for multilingual adaptive speech applications', *Proceedings of 6th International Conference of Spoken Language Processing*, Available at: http://www.cs.uta.fi/~tko/Tutkimus/hci/spi/reports/Jaspis-ICSLP2000.pdf, Access date: 24 December, 2012.

Turunen, M. and Hakulinen, J. (2000b) 'Mailman – a multilingual speech-only e-mail client based on an adaptive speech application framework', *Proceedings of Workshop on Multi-Lingual Speech Communication (MSC 2000)*, 11–13 October, Kyoto, Japan, Available at: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.33.7701, Access date: 24 December, 2012.

Turunen, M. and Hakulinen, J. (2003) 'Jaspis2 – an architecture for supporting distributed spoken dialogues', *Proceedings of the Eurospeech 2003*, pp.1913–1916.

Turunen, M., Salonen, E.P., Hartikainen, M., Hakulinen, J., Black, W., Ramsay, A., Funk, A., Conroy, A., Thompson, P., Stairmand, M., Jokinen, K., Rissanen, J., Kanto, K., Kerminen, A., Gamback, B., Cheadle, M., Olsson, F. and Sahlgren, M. (2004) 'AthosMail – a multilingual adaptive spoken dialogue system for email domain', Proceedings of Workshop on Robust and Adaptive Information Processing for Mobile Speech Interfaces, Geneva, Available at: http://www.ling.helsinki.fi/~kjokinen/Publ/200408COLING2.pdf, Access Date: 8 November, 2012.

Venkatesh, V., Morris, M., Davis, G. and Davis, F. (2003) 'User acceptance of information technology: towards a unified view', *MIS Quarterly*, Vol. 27, No. 3, pp.425–478.

Walker, B.D., Lackey, B.C., Muller, J.S. and Schone, P.J. (2003) 'Language-reconfigurable universal phone recognition', *Proceedings of EUROSPEECH 2003*, Geneva, pp.153–156.