ICT APPLICATION IN HIGHER EDUCATION: DESIGN OF AUTO-RESPONSE SYSTEM FOR STUDENTS’ ENQUIRIES (ASSE)

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Abstract
Student Support System is increasingly becoming one of the prioritised areas of concern in all tertiary institutions especially in Nigeria. Web portals are replacing the usual manual processes. Meanwhile students still find it challenging to have access to timely information anytime anywhere. The adoption of Mobile Computing and Telecommunication on portable devices such as ipads, smartphones, and handsets have made possible information delivery at the fingertips of users. With Computer-Telephony Integration (CTI), an Interactive Voice Response System (IVRS) can be deployed. This work therefore is based on the design of IVRS to fit into tertiary institutions Students’ Information Systems in Nigeria, Rufus Giwa Polytechnic being the case study. Rapid Application Development approach is adopted. The system is developed using VOXEPO Prophecy Server, HTML, Ajax-PHP, WAMP Server and MySQL with the school web portal to provide IVR Server and required database. The system is to eradicate errors, stress, delays and long queues in accessing timely and resourceful information as being experienced by students, while management personnel can generate flexible reports for timely decision making for running academic calendar more efficiently. The system performs optimally by delivering result to students with use of their mobile devices.

Keywords: web portals; computer telephony integration; databases; interactive voice response; client/server

INTRODUCTION
An Interactive Voice Response System (IVRS) processes inbound phone calls, plays recorded messages including information extracted from databases and potentially routes calls to either in-house service agents or transfers the caller to an outside extension (IVR, 2012). It is an interactive voice information and request system designed to take care of the most common questions asked by the shareholder service representatives with capabilities of enabling customers to use the keys on a touch-tone phone to access information, such as bank account balances, flight arrival and departure times, and package delivery status. This capability is provided by using a pre-recorded human voice stored on a computer hard drive, or by using text-to-speech technologies. These pre-recorded options are accessed via customizable touch-tone dialing (Dual Tone Multi Frequency-DTMF) phone menus (inōvdesigns, retrieved 2012).

The project Auto-Response System, a type of IVRS is designed to satisfy and meet the needs of student at-a-go. It involves integration of students (academic records) database with the IVR. The IVR is a technology that allows a computer to interact with humans through the use of voice and DTMF tones input via keypad (IVR, Wikipedia 2012). In operation, IVR allows students to interact with a school host system via a telephone keypad or by speech recognition, thereby routing service enquiries by following the IVR dialogue. IVR systems can respond with prerecorded or dynamically generated audio to further direct users on how to proceed (inōvdesigns, retrieved 2012). IVR applications can be used to control almost any function where the interface can be broken down into a series of simple interactions. IVR systems deployed in the network are sized to handle large call volumes.

IVR technology is also being introduced into automobile systems for hands-free operation. Current deployment in automobiles revolves around satellite navigation, audio and mobile phone systems.

Research in speech technology predated the advent of digital computers. It began with a speech synthesis project to a developed tone dialing methodology. This led to a blueprint for IVR. The early speech recognition systems were digital signal processing (DSP) technology based, and were limited to small vocabularies (Nuance Communications Inc., 2007). However, the era was changed to client/server architecture with the adoption of Voice Extended Mark-up Language standard VXML (VoiceXML forum, 2007).

The need and purpose of this system is becoming paramount as higher institutions in Nigeria have migrated to Web Application for students’ record processing. But students still find it difficult and delaying to get information relating to their academic information or any emergency alerts at any time. IVR became vital for deploying universal queuing and routing solutions to getting information delivered at the touch of mobile device’s button (inōvdesigns, retrieved 2012). This system, therefore, is designed to eradicate errors, stress, delays and long queues in accessing timely and resourceful information as being experienced by students, while management personnel can generate flexible
reports for timely decision making for running academic calendar more efficiently.

The system in a way does not provide users (students) with functionality to fill student’s registration form, generate receipts of payment or print relevant documents such as course forms and transcript on the user’s IVR device.

**COLLABORATIVE TECHNOLOGY**

Most essential technologies to work in cooperation for IVR deployment as shown in “Fig. 1” are the VoIP, Client/Server and Natural Language Processing. VoIP known as IP Telephony or voice/data solution is a generic term that refers to all types of voice communication using Internet protocol(IP) technology instead of traditional circuit switched technology. This includes use of packet technologies by telecommunications companies to carry voice at the core of their networks in ways that are not controlled by and not apparent to end users (J.W Gerald et al, 2002 and NACT, 2001). The real-time transmission of voice signals using the Internet Protocol (IP) over the public Internet or a private data network. In simpler terms, VoIP converts the voice signal from your telephone into a digital signal that travels over the Internet. One of the most significant advantages of VoIP (over a traditional Public Switched Telephone Network (PSTN - also known as a legacy network) is that one can make a long distance phone call and bypass the toll charge (NACT, 2001). It cooperatively works with client/server model, a computing model that acts as a distributed application which partitions tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients as depicted in “Fig. 2.” Often clients and servers communicate over a computer network on separate hardware, but both client and server may reside in the same system (M.L Scott, 1998)

Functions such as call operations and routing, email exchange, web access and database access are built on the client/server model. Most sophisticated call operations software for auto-response and phonetic interpretation uses Natural Language Processing(NLP), a field of computer science, artificial intelligence, and linguistics concerned with the interactions between computers and human (natural) languages. Many challenges in NLP involve natural language understanding - that is, enabling computers to derive meaning from human or natural language input (C. Ronan et al, 2011 and C.R Thomas, Retrieved 2012).

**INTERACTIVE AUTO-RESPONSE SYSTEM FOR EDUCATIONAL INSTITUTION**

Interactive Voice Response systems can play asignificant role in providing efficient customer service. Properly implemented, they can increase customer satisfaction, lower costs and offer new services. The return on investment (ROI) on these systems is also quite amazing, making them the most popular Computer Telephony systems in the world (S.P Mishra et al, 2012).

Information System (IS) is gaining wide acceptability in higher education with a range of applications such as Student Management Information System, School Web Portals, E-learning, etc. Students’ data therefore becomes resident on database. The database can then be harnessed by IVRs. The IVR’s get information from databases, convert to voice, and speaks it back to the caller. Practically all industry segments are potential users for this, and examples include phone banking (where you call in, dial your account number and Trading Partner Identification Number (TPIN) and can hear your account balance on phone), courier packet trace (where you call in, dial the Air Way Bill (AWB) number, and the system tells you whether the packet has been delivered, if it is in transit, etc).

In educational environment, the student calls the toll free number of the school and enters his/her matriculation reference number. On verification of matriculation reference number, the process will proceed with the pre-recorded voice messages, thus guiding him through the entire process.

**AIMS AND OBJECTIVES**

The pace at which Nigerian universities/Polytechnics education embrace automated processing from manual approach has been challenging over the years. The processes of requesting and obtaining academic information by the students in various departments and information units are too stressful and delaying. These information among others are:

- Information about their grades
- Teaching and Examination schedule
- Course Registration
- Certificate requests
- Library services
- General Information
- Directory Services

The objectives of this system therefore include:

- To design an IVR system called “Auto-Response System for Students Enquiries (ASSE)” to be integrated with an existing Student Information Management System.
- To setup a toll free number that reside in office and/or the office of the academic administrator with call trees and configurations designed to fit the needs of each academic operations.
- To secure student account information through matriculation Reference Number and Request ID.

![Fig 2] A traditional client/server system. Clients request services of the server independently but use the same interface (Source: Framework for Component-Based Client/Server Computing by Scott, M.L.)
• To empower students to access information on their own schedule with 24x7 availability.
• To provide the ability for students to transfer to an operator and/or an external extension.
• To provide comprehensive reporting for tracking volume and types of request, as well as studying trends and patterns from daily statistical reports evidencing request.

METHODOLOGY
This research work integrates student academic information system consisting of students seeking admission, enrolled and graduated students from Rufus Giwa Polytechnic, Owo, Ondo state, Nigeria, as a case study. The system was developed using VOXEO Prophecy Server, HTML, Ajax-PHP, WAMP Server and MySQL with the school’s web portal to provide IVR Server and required database, and at the same time make the system available online.

Related Works
IVR systems and the role they stand to play as a primary communications channel for businesses to interact with their customers is of critical importance to business success that these systems be as easy-to-use as possible. Some implementations are presented below.

Campus Emergency Alert Systems provides reliable and effective emergency alert system for higher education with the rise in violent attacks across our nation’s colleges and universities. Administrators of campuses, large and small, are equipped to proactively address the need for preparedness before the next event occurs. Key features are: both outdoor and indoor notification through audible alert, strobe and LED signage; integration with existing notification systems; Computer pop-up alerts via a client-based application for campus PCs (Campus Emergency Alert Systems, Retrieved 2012).

The virtual queuing solutions enhance the customer experience and improve operational efficiencies. The Virtual Hold software educates callers of the hold time and then offers them a choice: wait on hold or receive a callback when it is their turn to speak with an agent. Virtual Hold keeps their place in line and initiates a callback when it is their turn to speak with an agent (Virtual Hold Technology®, Retrieved 2012).

Voxify delivers customized, fully-integrated speech self-service solutions. Voxify’s technology enables intelligent and conversational speech applications that deliver an extraordinary customer experience. Offering the fastest time-to-benefit and highest performance, Voxify solutions deliver a superior ROI. As your business changes, Voxify’s managed service model ensures the ageless performance of applications (Voxify’s Patented Technology, Retrieved 2012).

Genesys-Angel is an enterprise focused, cloud-based, customer experience solutions, including the Caller First IVR and advanced solutions for SMS, voice, chat and BI. Its innovative IVR and voice applications that the caller first, every time, to elevate the customer’s service experience (Genesys-Angel IVR, Retrieved 2012).

PROPOSED SYSTEM
Design Standards
In order to achieve effective Voice Campus System, Rapid Application Development approach (RAD) is adopted. This is because RAD is a software development methodology that uses minimal planning in favour of rapid prototyping. The “planning” of software developed using RAD is interleaved with writing the software itself. The lack of extensive pre-planning generally allows software to be written much faster, and makes it easier to change requirements.

Design Details
The Interactive Voice Response System is a revolutionary technology that provides effective and efficient Computer-Telephony integration. This software solution enables the student to register a request and view the status of a launched request through their telephones.

The beauty of the system lies in the elegance and poise with which the database search and updating are performed. The student matriculation reference number provides the prime verification parameter. For request - registry, a large range of domains is presented to the caller in a pre-recorded voice format that enables him to be more specific. The ease with which a request is launched has been given the center stage of considerations, as it is all about student as customer - the most precious assets of any Institution.

Another striking feature of the system is the flexibility it provides in case of requests that the student is not equipped enough to categorize. Voice-mail is an option provided that enables the student to speak out the problem, record and save in a unique manner. The Service-Engineer then can playback this recorded request and identify the problem. This saves time and effort as minor problems can be solved without actually having to be on-site.

Most IVR systems are built into the phone system or are self-contained programs running on a separate system, allowing limited access to outside applications. This interactive voice response program can run on the same server that contains data and application programs. There are several advantages to using this technique.

IVR applications now have complete access to all the information available to existing database programs. IVR applications can be developed using traditional programming languages such as C, C++, or even COBOL through a rich set of IVR software API’s.

ASEA Architecture
Reference [16] described the main architecture of an IVR system by consisting of the following entities as adopted in our research work:

• Telephony Entity
• Speech Entity
• Administrative Entity
Telephony and Speech Entities are scalable according to the sizing and the capacity of expected simultaneous incoming calls based on Erlang analysis (an international unit of measurement for telephone use, equal to one caller using the telephone for one hour) which describes the system’s capacity depending on various parameter inputs.

Telephony Entity: The Telephony subsystem enables communication between the PBX/ACD (Private Branch Exchange/Automatic Call Distribution) infrastructure and the Voice Campus system. Moreso, as the runtime environment of the dialog flow, it is developed with the telephony software depending on the capacity of the Auto-responsive System (simultaneous calls served). It consists of a hardware server called the Telephony Server and depending on the PBX/ACD infrastructure.

Depending on the capacity of the ASSE with the required protocol, the telephony hardware voice board is selected to fit the need. ASSE uses an IP middleware application protocol in the case of VoIP implementations.

In addition, in this subsystem the telephony administration console is installed. This software application allows the administrator to monitor and manage:
- Telephony resources (number of telephony channels)
- Telephony protocol and signalling
- Voice resources
  - Speech resources (automatic speech recognition and text to speech)
  - Database connections (between the dialog application and back office systems)
- IVR scripts
- Log of calls
- Event viewer
- Alarm and notification in case of exceptions

Speech Entity: The Speech subsystem is hosting the Automatic Speech Recognition engines and Text to Speech engines that the ASSE uses. The system is offered by the engine necessary resources depending on the overall capacity and dialog usage of speech recognition and text to speech within the dialog itself. A dedicated Speech Server is also deployed for call flow because of its real-time nature and optimal performance.

The following details what the subsystem covers:
- Barge-in and Selective Barge-in
- Voice Activity Detection
- Background noise cancellation
- Acoustic models
- Speech grammars, synonyms and lexicons
- Linguistics and phonetics
- Text To Speech Language identifier
- Language Identifier

Administrative Entity: The Administrative subsystem is to offer the administrator, the web management tool. Themodule allows the administrator to manage the dialog operations and get statistic reports of the usage of the ASSE. The administrative subsystem supports:
- Overall call list of incoming calls
  - Specific reports per day, time or service used etc.
- Historical reports
- Dialog content management tool in order to edit the prompt “spoken” by the system and change it
- Service management tool in order to add, change or delete services and menus
- Dialog synthesis tool in order to change how a phrase is synthesized and spoken in the dialog

The Administrative subsystem is a website utilizing the Prophecy Server and can be installed in either the Telephony or Speech Server or anywhere in the network.

Topology of IVR: ASSE
There are two topologies standard that can be deployed in IVR system design viz: Time Division Multiplexer (TDM) and VoIP implementations. “Fig. 3 and 4” below detailed the network design. The PSTN in all the figures are being replaced with GSM (Global System for Mobile Communication) technology (V. Andreas et al. Retrieved 2012).
Interface Design
Considering the adoption of VoIP implementation for our work, the various interfaces that are used in the interoperability of the overall system is described in “Fig. 5”.

Procedural Chart
A call flow design diagram is used to show the activities flow and the program design sequence of the system “ASSE”. The call flow diagram is shown in “Fig. 6” with the list of audio response design sequence in “Fig. 7”.

Implementation
The project developed is tested for error-free performance and is subjected to proper implementation. Testing is considered as a destructive process that separates itself from other stages of the system development. The key objective of the testing process is to find errors in the program development. Testing measures to be taken are:

- Test to see if system requirement specification is taken care of.
- Test to see the proper handling of the input implementation in the organization. The various types of the user inputs.
- Test of the robustness of the system.
- Check for errors and validations of the inputs.
- Testing for the ease of use and degree of comfort of the students.

All the tests were done based on the sequence of modules. Each module is tested uniquely to detect the errors in the particular module and thus resulted in proper functioning of the application. See “Fig. 8” for sample outputs.

The followings are summaries as achieved in the system:

i. Good quality of voice
The system is expected to be executed in corporate intranet with a high bandwidth reserved. Therefore, the testing environment is fast Ethernet network running at 100 Mbps. Running at this bit rate, the voice quality is very good.

ii. Accept and Reject the call
Before communication is established, the caller needs to send a request to the callee and then waits for acknowledgment. This mechanism provides the callee with the capability of accepting or rejecting a call. On the other hand, the caller can also have a right to drop the call while waiting for the reply.

iii. Instruction provided
An instruction is played to the telephone users to teach them how to key in the callers IP address. Also the format of input IP address will be verified before a call request is sent out.
CONCLUSION

Student support system is increasingly becoming one of the prioritised areas of concern in all tertiary institutions especially in Nigeria. And IVRS is a technological targeted for the very same purpose. ASSE could be extended from wherein the requests registered by the students could be instantly e-mailed to the appropriate Service Engineer through complete automation. ASSE could be employed at a full scale in several educational institutions, including secondary school, tertiary institutions, education boards etc. It can also be used in the future, for casting votes during elections through our
telephone, smartphones or handsets. Research works are already on, with Computer Telephony Integration giving way for more explorations that could be done with IVRS to boost the value of human resources. In this research work we provide some recommendations geared towards future work in the design and deployment of ASSE. They are as follows.

**Phone-to-Phone Operation**
Since there is only one gateway in the Internet phone system, the system cannot support Phone-to-Phone operation. Thus, one possible future work is to implement one more gateway to put Phone-to-Phone operation in practice.

**Voice Conferencing**
Conferencing is one of the most popular services provided in the traditional telephony system. In order to replace the traditional telephony system and compete with the existing Internet Phone products, this VoIP gateway must provide voice conferencing function.

**Personal Phone Book and Contact List**
Another advantage of using a database system is that it can handle a large amount of data and provide personal services such as phone book and contact list easily.

**Data Recovery**
Since UDP (User Datagram Protocol) is used for data delivery, it is possible that some transmitted packets are lost or arrive out of order. This affects the voice quality. The system will perform better if there is a data recovery mechanism so that the system can still have data for playback, even though some data are lost or arrive too late.

**REFERENCES**


