Deployment of Vortal System for Realtime Information Service in Academic Institutions

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ABSTRACT

Accurate, reliable and well-timed information is essential to advantageous decision-making in nearly everything of human endeavour, whether it be undertaken via individuals, neighborhood organizations, agencies or governments. Realtime means of information access by various stakeholders is key to its utilization in decision-making. This paper provides a Vortal System that enable reliable, scalable, and intelligent real-time information access in a user-friendly way on a daily demand. Vortal system is an automated interactive voice response (IVR) telephone system that based on high-end speech recognition and text to speech (TTS) technologies. The proposed Academic institution Vortal System was designed to enable students and staff have access to real-time information from their cellphone set or cell phone through a simple voice call, even in circumstances the place no Internet connection or PC is on hand to obtain this information. The system allows the user talk at once barring the want of an agent, acknowledges the phrases or phrases "spoken" by using the person and right now serves their requests and this take away stress of waiting on queue at the administration places of work or trying to search for an Internet availability. It also helps to reduce valuable time spent by the administrative staff in handling routine information calls of users.

Keywords: Vortal, Voicexml, Telephony, Dialog Management, Mailboxes, Lexical Morphology

1. INTRODUCTION

The vision of any academic institution is to have operational and effective managerial process that enhance the achievement of her needs and goals. They achieved these needs and goals through proper administration of human and material resources. Administration according to **Hornby (2002)** is discovered as endeavor carried out to plan, organize and correctly run a business, school or other institution, a procedure or act of organizing the way that something is done. According to ***Eden (2006),*** administration involves planning things to do focused at the accomplishment of the goals of an employer or institution. Administration in institutional setting, has been prolonged as a provider recreation or tool from which the basic goals of the institutional procedure can also be more optimize efficiently when assigning human and material sources as well as to make the applicable use of existing ***sources (Liverpool & Jacinta,2013).***

Administrative activity like information dissemination in academic institutions had been enhanced with break-through in Internet and Web Technology instead of the usual ways of disseminating information through memos, letter, etc. In most academic institutions today, the internet email and web enable services are used to send notices and agendas to staff, submit lesson plans, process admissions as well as all day-to-day activities of the institution.

Information administration in academic institution is classified into student administration, staff administration and general administration. Student administration includes quite a few things to do opening from the admission process, follow by using getting to know activities to processing of outcomes and performance analysis. The incorporation of ICT into this process improves the normal admission things to do of educational establishments through making it more reachable to many (Thomas, 2004). For instance, admission process automation involves communication that includes admission enquiry by students, applying for admissions via electronic media, registration / enrolment using computers, course allotment, and availability of information like timetable / class schedule in electronic form and attendance monitoring / maintenance through e-media. Other communication in student administration includes the various communications relating to transport, hostel accommodation and other communication to guardians/parents. The incorporation of ICT in information dissemination also helps to remove barrier associated with increase in geographical boundaries for student enrolment and thus facilitating cross-border higher education.

According ***Christiana (2008)***, ICT fosters the dissemination of information and knowledge by differentiating content from its physical location and this flow of information is basically impervious to geographic boundaries permitting remote communities to become incorporated into global networks and making information, knowledge and culture handy in theory and to anyone. Staff administration comprises recruitment and work allocation of faculty and staff in the institution, their attendance and leave administration, and performance appraisal, relevant communication to and from the institutions and among peers. In ***Thomas (2004),*** "staff administration done through Information and communication technology (ICT) helps in processing of voluminous records in a quick, meticulous, and impeccable manner thereby making data retrieval easier". General administration is a very vital part of information administration in academic institutions that includes the various day-to-day activities of the entire system such as the use of electronic media for scheduling of halls and other resources, payment of fee, and handling internal and external examination activities in coordination with the school examination committee members, all day to-day activities, intra and inter communication and so on. In fact, a good communication system is needed for the overall effectiveness of information administration and ***Magni (2009),*** opined that ICT helps a lot in providing timely information to all concerned through good communication system in higher education system.

1.1 Problem Statement

Most academic institutions in Nigeria generate lots of administrative information for the use of students, parents and staff. The generated information may include but limited event reminders or announcements, extracurricular events, time/venue changes of events, emergencies and school closures, information about course/subject grades, teaching/lecturing and examination schedule, class registration, certificate requests, library services, medical service, tuition fee, directory services, general Information, etc. Each category of the information above is made available to students', parents and staff in some of these Schools through conventional paper-based mode of newsletter, memo, which displayed on noticed board or made available on individual request by administrative staff.

This paper-based mode of information dissemination has low user coverage and slow access, thereby rendering acquired information irrelevant for decision-making. Today, few schools have started utilizing the potential of the internet to provide easy access to vast resources of information to students, parents and staff. The use of the internet requires computer-based internet experience from users and computer-based access is limited for the mobile professional who do not have internet in their current location. Also, the computer-based Internet experience requires visual display of information and keyboard-based interactions, which does not meet the information needs of visually impaired users. Another issue identified with internet experience for information dissemination is the information overload that results in service delays and increase bandwidth consumption cost of the user.

1.2 Objectives of the Study

The growing users' demands are focused on the need to have a natural interface that permit users to speak and hear instead of seeing and clicking, which would provide them experience on the use of Internet as well. The aim of the study to design a system for realtime information access for academic institutions based on ***voice portal technologies*** where students can be provided services such as access to grades, exam timetable, weekly deliverables programs, and requests for official documents. The specific objectives of study are:

1. To minimize the total time spent by students waiting to be served by their departments
2. To enable students to use Internet information anytime and anywhere using the most common access device and the most natural way of communicating - telephone interface.
3. To meet the information needs of visually impaired users who will not be able the convention visual based noticeboard and web portal.
4. To design Vortal system that integrated with an existing Student Information Management System and easy setup of 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.
5. To allow students to access information through matriculation Reference Number and Request ID. on their own schedule with 24x7 x 365 availability.
6. To provide adequate and comprehensive reporting for tracking volume and types of request, as well as studying trends and patterns from daily statistical reports evidencing request.

The next section of this paper contained a literature review of the voice portal technology and its architecture as well as information flow pattern of typical voice portal system.

2. LITERATURE REVIEW

The ***voice portal technologies*** also known as Vortal technologies has been developed to meet yearnings of various users. According to ***Priya and Ramakrishna (2002),*** *Voice Portal is defined as "a system that enables customers to access information on the Internet through a telephone interface. It uses technologies like Speech Recognition and Text to Speech (TTS) conversion to create a user interface and let users navigate through the "voice web page" using a phone and voice commands. The idea behind a voice portal is to enable customers to use Internet information anytime and anywhere using the most common access device and the most natural way of communicating".* The voice portal is a combination of hardware and software that utilizes technologies of speech recognition through phone and text-to-speech command to communicate in a most natural way.

The voice portal evolved from the interactive voice recognition (IVR) Technology and several innovative changes in communication, which has led to emergence of the internet, availability of digital device and the need for personalize experience in communication. In ***Erica et al (2001),*** they commented that "*most applications accessing the Internet or delivering messaging services require the use of traditional access methods like a Web browser with some type of pointing device or a DTMF (Dual-Tone Multi-Frequency) keypad".* It is not convenient for everybody to effectively communicate with web browser tools to access the internet especially the visually impaired. ***Luvai (2009),*** *said that "while interactive tools are relatively easy to use for people with full eye-sight, they are incompatible for people without eye-sight (or blind-disabled)".*

The interactive voice recognition technologies of automatic speech recognition (ASR)and text-to-speech (TTS) has the capability to provide the much needed for disable user and thus, overcoming access and user interface deficiencies. Speech recognition technology is a cryptic and costly technology that has traditionally been used by only big businesses and research labs. ***Luvai (2009)****, opined that "Combining speech recognition with the simplicity of markup languages like VoiceXML makes it dramatically simpler to develop a Voice User Interface (VUI)*". The VUI allow voice-based interactions between humans and machines through natural language processing. Several voice-based assistants the incorporated the VUIs have been developed and they are rapidly gaining in popularity like Siri (Apple), Cortana (Microsoft), Google Now and Amazon Echo. The popularity of these voice-based assistants can be linked to break-through in the field of artificial intelligence and natural language processing and this have made possible speech recognition to comprehend verbal commands. Some of these *voice-based assistants such as Amazon Echo and Google Home have entered the market as standalone devices and are being applied for tasks like performing searches, look up information, answering questions, making recommendations, playing songs, integrating with other devices and third-party services for performing various tasks like booking tickets, getting news, etc. which can gradually replace smartphone apps* ***Sanil Pillai (2016).***

The flexibility of customer shifting from a self-service to an agent-assisted transaction as needed is made possible by speech-driven self-service, which speedy and easy to install, but additionally handy to configure. The voice Portal can additionally be combined with current Web databases and applications via "VoiceXML."

In 2000, the voice-extensible markup language (VoiceXML) was released publicly by the VoiceXML Forum to enable programming and management of voice response applications that include telephony features such as call transfer, mixed initiative conversations, recognition of spoken and dual tone multi-frequency key input, audio dialogs that incorporates synthesized speech and digitized audio. The VoiceXML supports Unicode via the "xml:lang" attribute, a technique for exact control of the input and output languages and the capacity to interpret input in a language unlike from the output language(s). The VoiceXML is further strengthened to provide global services through the introduction of the recently expanded language support for French, Italian, German and Spanish ***(Shadbolt, 2003).*** Today, voice portal technology has now replaced the once-proprietary vendor IVR box in a legacy contact center system, where software developed in Java, PHP, or

.Net that resides on a standard -based application server and accepts commands from a special server-based voice browser that in turn receives pages back from the application server using VoiceXML

2.1 The Model of Voice Portal System

Voice portals put all kinds of information at a consumer's fingertips anytime, anywhere. It utilized a conversational agent that accepts natural language as an input and produces natural language as an output engaging in a communication with the user ***(McTear et al., 2016; Pieraccini,2012).*** As soon as the conversational agent has recognized what the user uttered, then it is necessary to understand what the user said. For successful management of the communication with the users to achieved, conversational agents, regularly performed five basic tasks: automatic speech recognition (ASR), natural language understanding (NLU), dialog management (DM), natural language generation (NLG) and text-to-speech synthesis (TTS). Speech recognition according to ***Rabiner and Juang (1993)*** *and* ***Baker et al. (2009)*** is "the process of obtaining the text string corresponding to an acoustic input". It is a very difficult task, which made up of lots of variations in the input characteristics, that can differ depending on the linguistics of the utterance, the speaker, the interaction context and the transmission channel.
Griol and Molina, (2016), *states that "*Linguistic variability involves differences in phonetic, syntactic and semantic components that affect the voice signal. Inter-speaker variability refers to the big difference between speakers regarding their speaking style, voice, age, sex or nationality".

Minker (1998) and Baker et al. (2009), defined Natural language processing as *"the process of obtaining the semantic of a text string, which generally involves morphological, lexical, syntactical, semantic, discourse and pragmatical knowledge."* Lexical and morphological knowledge enable splitting the words into their respective components differentiating lexemes and morphemes, while syntactic analysis produces a ordered structure of the sentences. The semantic analysis generates the meaning of a complex syntactic structure based on the meaning of the components of the sentence whereas the sentence is interpreted in the context of the whole dialog at the pragmatic and discourse processing stage. The dialog management carry out different tasks since no universally agreed designated task but ***Traum and Larsson (2003)*** state that "*dialog management involves four main tasks: i) updating the dialog context, ii) providing a context for interpretations, iii) coordinating other modules and iv) deciding the information to convey and when to do it*". According to

(Griol et al., 2014; Bohus and Rudnicky, 2003), the dialog manager handle information for different sources like the NLU results, database queries results, application domain knowledge, knowledge about the users and the previous dialog. Natural language generation is responsible for converting text in non-linguistic representation into natural language form using a simplified approach that is based on predefined text messages (e.g. error messages and warnings). Finally, the voice signal that will be transmitted to the user is generated by a text-to-speech synthesizer ***(Griol and Molina, 2016).***

2.1.1 Architecture

A typical Voice Portal System consists of: *VoiceXML Server and Web Server*, which are connected to together via HTTP. The *VoiceXML Server* is made up of Telephone Gateway Component, TTS Engine, ASR Engine and VoiceXML Browser. The core telephony features such as DTMF (Dual Tone Multi-Frequency) extraction and detection, call placing, call transfer and call termination are provided by the *Telephone Gateway Component.* It allows telephone networks such as PSTN (Public Switched Telephone Network), a normal analog line or lines entering via a PBX (Private Board Exchange) system, ISDN (Integrated Services Digital Network) lines or VoIP (Voice over IP) network to connected to the VoiceXML server. The user can initiate voice/audio input through the telephones can be normal phones or IP (Internet Protocol) phones if connected to the VoIP network.

The *TTS (Text-to-Speech) engine* is responsible for generating the speech output from text that is sent to the engine by the VoiceXML browser.

The *ASR (Automated Speech Recognition) engine* is responsible for recognizing the user utterance and converting it into text, which is forwarded to the VoiceXML browser. The *VoiceXML browser* is the key component that requests VoiceXML documents, interprets them and controls the dialog flow. It also controls speech and telephony resources. These resources include ASR (Automated Speech Recognition), TTS (Text-to-Speech), play/record audio, and telephony network interface. Typically, a single instance of VoiceXML browser has an instance of the ASR and TTS engine. If there is a need to grab user input, it passes control to the *ASR engine*. For generating speech output, it passes the request to the *TTS engine*. If the audio output is prerecorded audio, the VoiceXML browser forwards the raw data to the telephony component **(*Priya and Ramakrishna, 2002).***

The *Web Server* is responsible for running the application logic and possibly might include VoiceXML document, database of grammar Files and audio Files or interface to an external database or transaction server. The *VoiceXML document* define the voice user interaction and dialog flow control. The VoiceXML document used VoiceXML language to provide information for features of four major components of Voice Web: voice dialogs, platform control, telephony and performance. Thus, each VoiceXML document consists of one or more dialogs. The dialog features cover the collection of input, generation of audio output, handling of asynchronous events, performance of client-side scripting and dialog continuation. Telephony features include simple connection control z (call transfer, add 3rd party, call disconnect) and telephony information like Automatic Number Identification (ANI) and Dialed Number Information Service (DNIS). VoiceXML provides authors close control on performance by providing features for caching and prefetching (fetchhint) the documents and grammar files. The *Grammar Files* define the valid commands that are allowed during the voice interaction and grammar can be defined at the development stage or generated dynamically at the run time. The *Audio Files* are prerecorded audio files that are played back, or the recordings of the user's input **(*Priya and Ramakrishna, 2002)***. The above described features of Voice Portal system are presented in Figure 1 below:

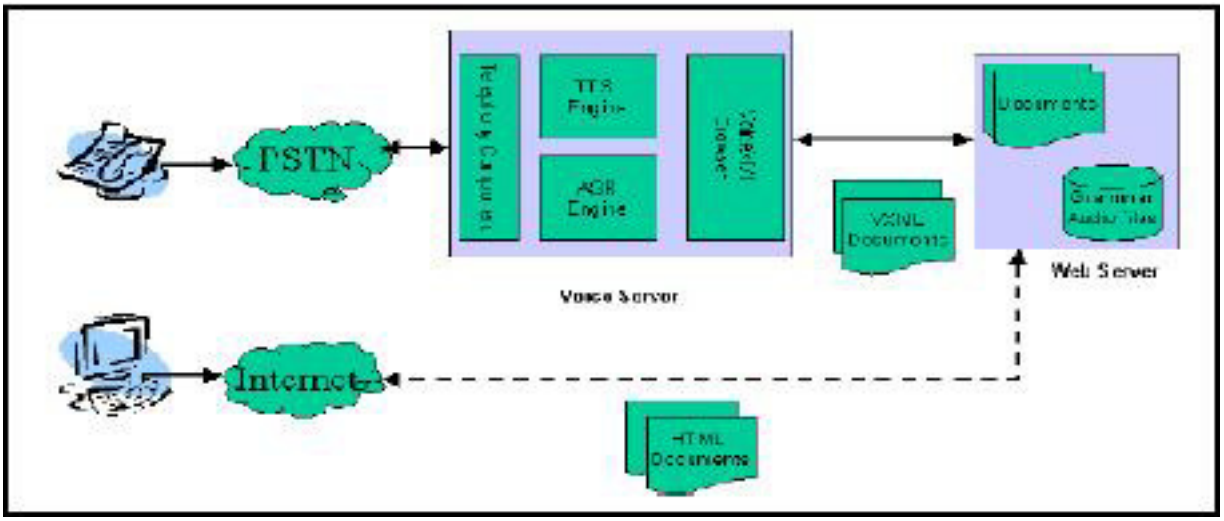

Figure 1: Typical Architecture of Voice Portal System (*Priya and Ramakrishna, 2002)*

2.1.2 Information Flow

Voice portals are the voice equivalent of web portals, giving access to information through spoken commands and voice responses. Ideally a voice portal could be an access point for any type of information, services, or transactions found on the Internet. Voice Portals can now be accessed through mobile devices and Far Field voice smart speakers such as the Amazon Echo and Google Home ***(Sanil Pillai, 2016)***. Common uses include movie time listings and stock trading. In telecommunications circles, voice portals may be referred to as interactive voice response (IVR) systems, but this term also includes DTMF services. The information flow pattern is similar in each of all conversational assistants such as such as Apple's Siri, Amazon Alexa, Google Assistant, Microsoft Cortana, and Samsung's Bixby. An example of call flow in typical voice portal system presented in figure 2.

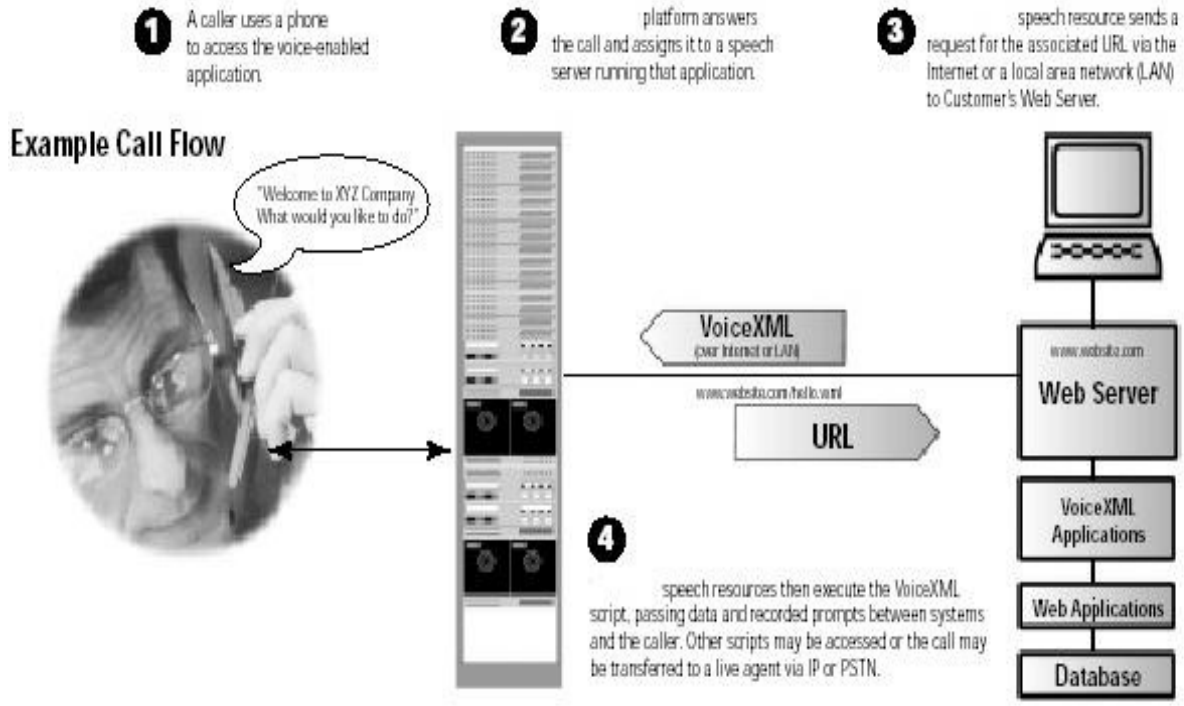

Figure 2: Information Flow Model (*Priya and Ramakrishna (2002)*

3. METHODOLOGY

The research approached adopted in this study is a client-server software development technique that used the Interactive Voice Portal System Architecture of (***Griol & Molina, 2016)*** of Figure 3 below. The adopted architecture incorporates *VoiceXML Server, which provides the VoiceXML standard 3, the ASR interfaces, TTS interfaces, VoIP as well as telephony technologies* and a set of *web servers*, which connects to the IVR via Internet provide dialog management facilities, grammars and system prompts, and the access to the information and different web services.

The VoiceXML server was implemented using *Voxeo Evolution platform 5, a* VoiceXML language interpreters and *Prophecy 9 Multi-Language VXML*, which allowed application to be developed for users in different languages. The Web servers was implemented with *PHP and VXML* files for each service provided by the voice portal and *MySQL* for databases containing the specific information.

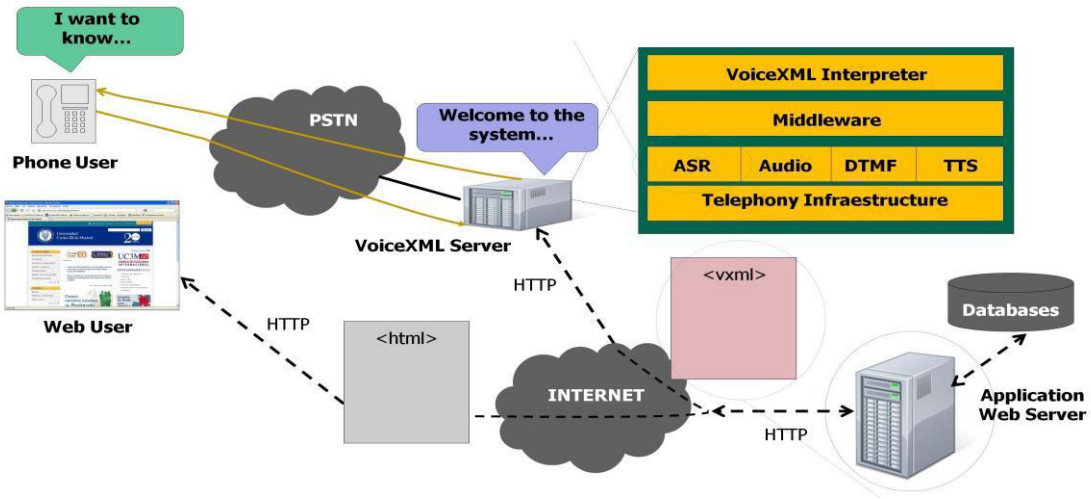

Figure 3: Interactive Voice Portal System Architecture (Adapted from Griol & Molina, 2016)

The above Interactive Vortal System Architecture in Figure 3 was implemented for the proposed Academic Institution Vortal System with three subsystem interfaces: Telephone Subsystem, Speech Subsystem and Administrative Subsystem. The Telephone Subsystem providing interface for communication between the Vortal system application and PBX/ACD, runtime environment for dialog flow. It also incorporates and utilized telephony administrative console to manages and monitor operation related to Telephony Resources (number of telephony channels), Telephony protocol and signaling, Voice Resources, Speech Resources (automatic speech recognition and text to speech licenses), Database connections (between the dialog application and back office systems), IVR scripts, Log of calls, Event viewer, Alarm and notification in case of exceptions.

The Speech Subsystem is interface that incorporates Automatic Speech Recognition (ASR) and Text-To-Speech Engines. It manages all speech and Text-To-Speech Sensitive Parameters of Vortal system such as 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 and Language Identifier. The administrative subsystem is an interface that provide web management tool for administrator to manage dialog operations as well as obtain statistical reports of usage of the Vortal system. In summary, this subsystem supports operations such as reports on overall call list of incoming calls, historical reports, specific reports per day, time or service used etc.; dialog content management tool to edit the prompt "spoken" by the system and Change it; dialog synthesis tool to change how a phrase is synthesized and spoken in the dialog, using simple excel functions and service management tool to add,

change or delete services and menus. The implemented interface design of the Interactive Vortal system is capture in the UML Component diagram of Figure 4:

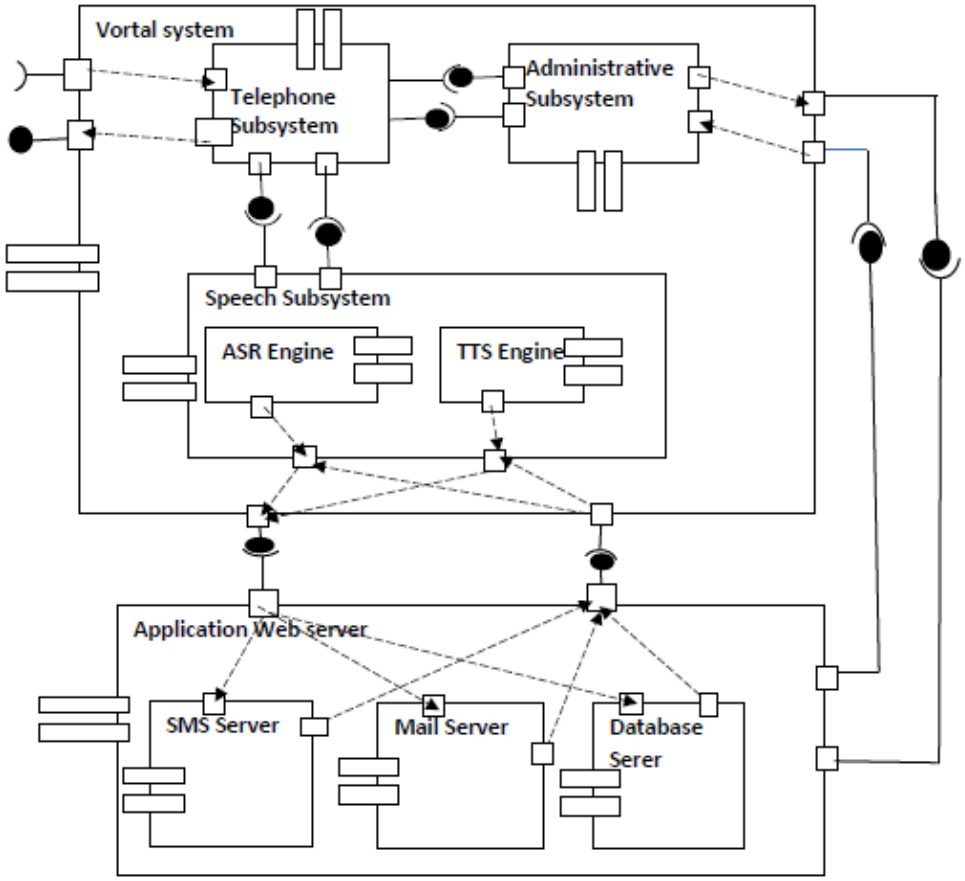

Figure 4: Component Diagram of Academic Institution Vortal system

4. RESULTS

The designed *Academic Institution Vortal System Application* provides exciting features such as students automated notification service for emergency notifications, attendance calls, informational messages, and a variety of other school-related notifications. With this application, the students can make call to the institution, enter their student personal code and pin through the digits of their telephone set and have access to personalized information retrieved from the back-office systems of the institution. Likewise, additional services are "available" to the callers, devoid of the quest to logging to the system. The benefits of the deigned application include: grade information, teaching and examination, class registration, certificate requests, library service, directory service on campus, SMS messaging, SMS alert and notifications, voicemail and email. For instance, the users can call to learn about facilities, registration procedure, access, general operation rules and any other information which the college would like to publish over the phone.

They can be informed of contact information to specific departments of the Institution and can even be used by the system to connect to the direct extension of these departments. Also, the service can be made available to the students via SMS messages, in case they leave their mobile phone number.

Furthermore, the Vortal system can be used to extend existing service and students can request an alert or notification for some services with respect to examination date, class registration deadline, availability of a library document etc. The application permits users to leave voice messages, which is stored in voice mailboxes and sent as attachments in the form of ***.wav file*** to email of the corresponding voice mailbox for some employees or departments within the college. Students can apply and register for the semester courses by phone based on criteria defined by the Institution rules and regulation. Finally, the student request for the grade obtained during specific examination period by providing requisite historical data in the given periods for this class. can obtain information about the weekly teaching schedule as well as the exam date course. Moreover, request for students' certificate documents from the department such as grade analysis etc. as well as apply to borrow a specific title in the department's library, learn the availability of specific documents etc. is made available through application.

5. CONCLUSION

In this paper, a review voice portal technology is presented and applied to solve the challenges experienced by academic institution in the administrative dissemination of information to students and staff. The application allows user to get real-time information from their telephone set or mobile phone through a simple voice call, even in circumstances where no Internet connection or PC is accessible to obtain this information. Also, the user can dialogue directly without the need of an agent, recognizes the words or phrases "spoken" by the user and immediately serves their requests and this eliminate waiting on physical queue at the administration offices or attempting to search for an Internet access point. It also helps to reduce valuable time spent by the administrative staff in handling routine information calls of users. The Academic Institution Vortal system utilizes cutting edge technology with open architecture and the system use an intelligent and friendly algorithm for the authentication of each student to utilize the personalized services via his/her Student ID Number and a PIN number issued.

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