A Voice-based Mobile Prescription Application for Healthcare Services (*VBMOPA*)

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Abstract: Adverse drug effects are a major cause of death in the world with tens of thousand deaths occurring across the world each year because of medication or prescription errors. Many of such errors involve the administration of the wrong drug or dosage by care givers to patients due to indecipherable handwritings, drug interactions, confusing drug names etc. The adoption of voice-based mobile applications could eliminate some of these errors because they allow prescription information to be captured and heard through voice response rather than in the physician's handwriting. This paper presents a design and implementation of a Voice-based Mobile Prescription Application (*vbmopa*) to improve health care services. The application can be accessed through a mobile phone by dialing an appropriate number. This system could lead to costs and life savings in healthcare centres across the world especially in developing countries where treatment processes are usually cumbersome and paper based.

Keywords: Dosage, Drug, Healthcare, Mobile, Pharmacy, VoiceXML, VUI and UML

I.   INTRODUCTION

The need to improve health delivery services and provide efficient heartcare has resulted in a dramatic increase in the use of Information and Communications Technology (ICT) based solutions in the heartcare sector. Although the Internet has received significant attention in recent years, voice is still the most convenient and natural way of communicating between human to human or human to computer. Voice eXtensible Mark-up Language (VoiceXML) technology allows a user to interact with the Internet through voice recognition technology by using a voice browser and /or the telephone [1]. VoiceXML is the new standard for developing speech and touch-tone applications. The technology brings Interactive Voice Response (IVR) into the Internet age, leveraging the same content and infrastructure used by web applications, and capitalising on open standards to reduce cost and increase efficiency [2]. Voice-enabled systems are applicable in several areas including information providers such as stock, flight, financial institutions [3], customer services [4], e-Learning [5] and a lot more.

With mobile voice technologies, medical practitioner are able to instantly update and retrieve patients' records from anywhere within a telephone network coverage. This ensures that the patients' medical records are always current. Physicians with up to date information are likely to make better prescription decisions. Apart from enhancing quality of patient care, the adoption of voice-based application could through the elimination of redundant paperwork, also facilitates more efficient and effective delivery of patient care. Voice-based applications are designed basically to eliminate the number of prescription errors as well as facilitate real-time access to medical records thereby decreasing back-and-front office inefficiencies associated with script writing [6] and to provide accurate bills. Voice-based application could be designed to support functionality that automatically alert the physician if the medication prescribed will react adversely with other medications.

The objective of this paper is to design and develop a voice-based mobile prescription application (*vbmopa*) that offers an alternative e-health platform to complement the existing mobile healthcare delivery system. Voice-

based mobile prescription system is a system of healthcare delivering services that can take place anytime, anywhere with the help of a mobile phone by dialing a telephone number that connect users to an e-prescription application that is resident in a web server. Having determined some requirements and objective for the system, in the next section we shall discuss the modelling and design of *vbmopa*. Section 3 presents system implementation and section 4 conclude the paper.

II.   SYSTEM MODELLING AND DESIGN

Although VoiceXML is easy to learn, building a successful VoiceXML application requires not only software development skills, but also other skills like understanding human factors for the telephone interface, linguistics, speech recognition and audio production. The VoiceXML application development life cycle [7, 8] contains the steps for building voice applications. The steps are similar to web application development stages but include voice user interface (VUI) design and speech recognition system. The Unified Modelling Language (UML) was used to capture and model some of the functionalities in the application. The UML is a visual language that provides a means to visualize, construct and document the artefacts of software systems [9]. In the next section, we modeled a drug prescription scenario with a UML diagram

A.   *UML Modeling*

During treatment processes in most typical hospitals, once a doctor has diagnosed a patient's ailment, he prescribes the drugs which are expected to be dispensed in the right quantity and taken in the right dosage for the treatment. At the dispensary, drugs are dispensed by the pharmacist based on instructions by the doctor. The UML state chart in Figure 1 captures this scenario. Where a drug is not available, it is reordered from the store or the manufacturer and dispensed to patient.
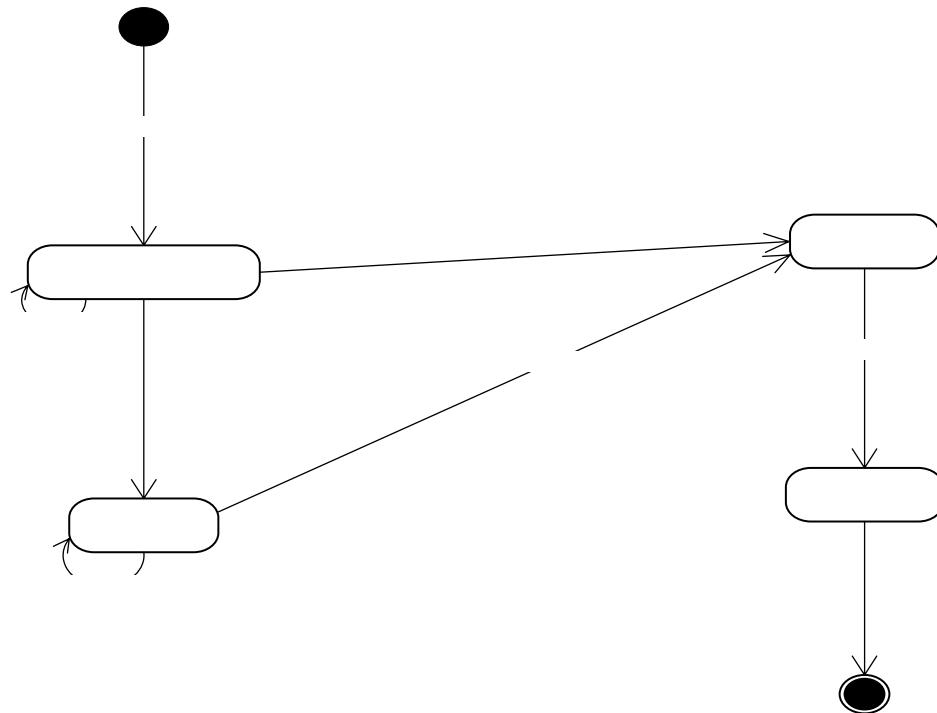

Figure 1: State Chart for Medication

B.   VUI Design

Every authenticated user of the application will undergo some questions and answers session, which will be matched against the content of the database, and the result received by the user through voice response. The sample call flow for prescription of malaria treatment with *vbmopa* is presented in Figure 2.

IVR: Welcome to Voice-based Mobile
        Prescription Application (*vbmopa*).
        To login into the system, you must be
        one of the following users: patient, lab
        attendant or phamacist.
IVR: Welcome to patient menu. What is your
        card number.
User: Say [card number]
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IVR: PATIENT MENU
IVR: Say "drug prescription" For drug
        prescription.
 IVR: Say "drug dosage" For drug dosage.
IVR: Say "drug administration" For drug
        administration
IVR: Say "exit" to exit the system
        [prescription menu selected]
IVR: Welcome to prescription menu.
IVR: 1 packet of antecinate and 1 packet of
        paracetamol is prescibed by the doctor
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[dosage menu selected]
IVR: Welcome to dosage menu.
IVR: You are to take 3 tablets, 200milligram of
        antecinate twice daily for five days, and 2
        tablets of paracetamol three times daily
        for seven days.
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[exit menu selected]

IVR: Welcome to exit session. Good bye and
        have a nice day.

  Figure 2: A sample call flow for *vbmopa*

C.   SYSTEM ARCHITECTURE

Figure. 3 presents a 3-tier client and server architectute for *vbmopa*. It contains client devices, servers and a backend running MySQL database.

Client Devices
The client systems include VUI devices such as mobile phones (Personal Digital Assistant (PDA), cell phone and smart phone and other handheld communication devices).

Servers

The server contains the voice and web server. The speech server (gateway) contains the automatic speech recognition (ASR), text-to-speech (TTS) and voice browser. The web/application server stores the voice-based health-care content information. It uses HTTP to maintain Internet connectivity with the voice gateway. The robust web/application server provides real-time access to the health information database.

Databases
The database used is MySQL. It stores the information about diagnosis, prescription, drugs and drug administration. MySQL is a server application (for database) able to carry out a great number of SQL commands [10].
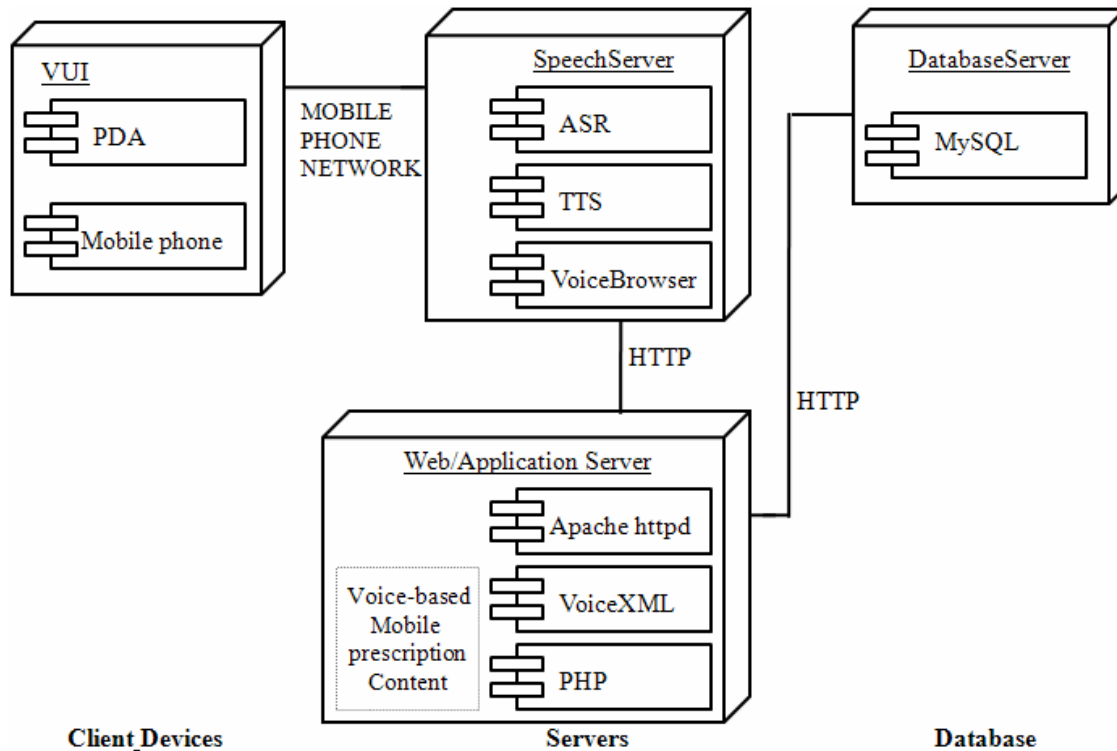
Figure 3: System Architecture for *Vbmopa*

III.   SYSTEM IMPLEMENTATION

We developed the application using VoiceXML to render voice response to the phone interface. Hypertext Preprocessor (PHP) scripting language was used for the development of the server side application which runs on an Apache server. MySQL was used as the database. The VoiceXML was preferred amongst other competing tools for developing telephony application, such as Microsoft .NET Speech Technologies because of its scalability and platform independence. The choice of PHP, Apache and MySQL is because they are free and open source [11] which makes it more economical to develop with at the prototyping stage.

The application can be accessed through a local computer and telephone as follows.

A.   Local computer
A Voxeo Prophecy phone emulator was downloaded [12] and installed on a local computer and used to develop the voice user interface (VUI) application. A headset was connected to the local computer for the caller to get voice response and also be able to supply voice input. Clicking the Dial button from the Voxeo Prophecy SIP Softphone keypad (see Figure 4) allowed connection to the application for access to the various services provided by the application. Once connected, the application prompts with a welcome message and go ahead to authenticate the user's name and password before any transaction can take place. The application will ask for the services demanded by a patient and go ahead to process the request.

B.   Telephone
A prototype part of the VoiceXML application (voice user interface) was deployed on a Voxeo voice server [12] on the web and accessed from any telephone using the format:<source country int. dial out #> <destination country code><destination area code><generated voice network 7 digit #>. Dial: 009-1-412-5284144

or 009-1-206-7925679 from any mobile or land phone from Nigeria (009) will connect to, and execute the application. To access the application from another country, replace 009 with source country int. dial out #. The default patient card number to log in is *cartman*.

Figure 4: Voxeo Prophecy SIP Softphone keypad   Source: [13]

IV.   CONCLUSION

The voice-based mobile Prescription application (*vbmopa*) discussed in this paper, allows physicians with mobile phones devices within a telephone network coverage capture and view patients' medicatiion details. This is a step toward enhancing the efforts being made to avoid problems of prescriptions by care providers. The access to the patient's medical records real-time improves patients' care by ensuring that correct information such as the appropriate medication to be administered is retrievable.   In addition, the application improves efficiencies of health care services by eliminating time-consuming call-backs that may be associated with treatment processes.

The future research direction for this paper is to evaluate the system using the method proposed in [14] called PARAdigm for DIalogue System Evaluation (PARADISE).

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