Indian Journal of Science and Technology, *Vol 9(44), DOI: 10.17485/ijst/2016/v9i44/105316, November 2016*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Multi-Channel Communication System for Healthcare Domai

R. Sethuraman, C. Daniel Nehemiah Anand and Gouru Sumanth

Sathyabama University, Rajiv Gandhi Salai, Jeppiaar Nagar 600119, Chennai, Tamil Nadu India;
srssethuraman@gmail.com, danielnehemiah@rocketmail.com, sumanthgouru@gmail.com

Abstract

Objectives: The objective of this paper is to propose a new and effective method of communication between hospitals and patients for the treatment and rehabilitation process leading to higher patient retention and lowered lapse of treatment. **Methods/Statistical Analysis**: The method used for this communication is a culmination of Cloud Telephony and Web technologies. Interactive Voice Response System, SMS and mailing services are the main components involved in sending and receiving information between the hospital and patients. The method used to get information from the patients is through Dual Tone Multiple Frequencies (DTMF) tones, which get generated every time a user presses a button on his (or) her phone. **Findings:** It has been found that IVR communication is more effective and consumes lesser human labor than all other reminder techniques in the current times. IVR has proved effective mainly because the hospital communications are generally one sided. When using automated systems like cloud telephony it has been found that the system will fail to be without proper pattern recognition algorithms and solutions built to work in a variety of conditions. The proposed system has the potential to influence and enhance the patient-hospital communication because it has a database of information about the patient and a way of communication that is easily relatable to human beings coupled with algorithms which take into account the various possible scenarios that could happen at the user end. Calls made by the system are customized based on patient details: to communicate with illiterate patients the IVR call can be made in their own native language. The novelty of the system is that it not only helps hospitals with screening, surveying and providing preventive solutions but also helps in the treatment process. **Application/Improvements:** The applications of the system are as vast as the types of communications that hospitals and patients have. The system can be modified to fit all hospital-patient communication requirements. The system can be improved by adding more communication channels like mobile apps and also by improving the call logistics using machine learning concepts.

Keywords: Cloud Telephony, DTMF, Interactive Voice Response, SMS

1. Introduction

Patient hospital communication is a vital part of any treatment. Patients are always in need of information and clinical help however it is not easy to get these without going to the hospital. Diseases like cancer cannot be cured in a single session or two but need a long term treatment, meaning the patient must frequently visit the hospital. Since many cancers are malignant it is very important for both hospitals and patients to ensure that the patient undergo regular check-ups. In this situation the patients must be informed beforehand about their appointments. Since there will be hundreds of patients in a hospital, the appointments will take a lot of time to schedule. Therefore we need to inform the patients in a reliable way and get a confirmation from them. Adyar Cancer Institute, a cancer specialty hospital rated as the Top Ranking Centre in India by World Health Organisation (WHO) sees 1,25,000 patients annually who are drawn from all over India, parts of South and South East Asia. Over 66% of them are indigent and are treated free of charge.

To make sure patients come for regular check-ups Adyar Cancer Institute reminds its patients about their appointments by sending letters. Writing and posting let-

**Author for correspondence*

ters for each patient based on their language is a herculean task; this can be solved by our system in an efficient way by making Interactive Voice Response (IVR) calls to the patients. Using IVR we can communicate with patients in their native language through an automated phone call and remind them about their appointments. We can also call multiple patients in parallel at the same time, reducing the time of this process.

The proposed communication system may also be included as a special feature in a general healthcare suite[1].

The proposed system acts as a multichannel communication between the patient and hospital as it uses both SMS and IVR channels. Our system can readily integrate with Med Mantra (a healthcare system developed by TCS) to manage the patient details in hospitals and being used by Adyar Cancer Institute.

The IVR solution has been used in the healthcare domain for some time now and has given very good results, this is the main motivation behind this paper in addition IVRS have been used for surveys and have been found effective[2]. Some related works are as follows:

1.1 Use of Interactive Voice Response to Improve Colorectal Cancer Screening [3]

This paper explores how cancer screening can be improved by the intervention of an IVR to encourage colorectal cancer screening. The IVR intervention was associated with a 32% increased likelihood of CRC screening.

1.2 Interactive voice Response Reminder Effects on Preventive Service Utilization[4]

This study evaluated the effects of IVR system reminders to Managed Care Organization (MCO) members to obtain mammograms, Papanicolaou (Pap) tests, and influenza immunizations. There is justification for more IVR interventions and research to enhance MCO members' preventive service utilization.

1.3 IVRS in Health Care Services[5]

Recent advances in telecommunications technology have created opportunities to enhance the quality of health care services through telehealth, the use of telecommunications and information technologies to deliver health care. However, the diverse technologies and applications encompassed by telehealth have tended to confuse discussions of the effectiveness of these programs. An Interactive Voice Response System (IVRS) is a simple, yet effective telehealth application that improves access to health care by continuing care beyond the hospital setting, with specially tailored programs that are easily accessible to patients around the clock.

The first hospital to use the system will be Adyar Cancer Institute, Chennai, India they will use it to remind their cancer patients when he/she must visit the hospital next. Both hospitals with and without a hospital management system can use this system.

2. Methodology

Cloud computing is an internet based computing system where services are provided on demand and paid for per use. Cloud providers pool together a large number of computer resources and allow clients to access these resources as needed. There are commonly three types of services which are provided on the cloud: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The new trend in cloud services is Communication as a Service (CaaS).Cloud communication is way of communication where we can reach a vast number of clients through IVR, SMS and e-Mail. Both SMS and e-mail are traditional way of communication whereas IVR is a new cost effective, flexible method that allows for a feature rich, automated phone call to convey information and get feedback. Ozonetel Systems is one of the market leaders in providing cloud solutions, their cloud IVR solutions are provided through KooKoo. It provides 4 shared and one dedicated port from its E1 telecommunication line allowing us to make multiple calls concurrently.

Multi-channel communication system for healthcare requires a powerful web based programming language to interact with the cloud telephony system and also develop an IVR application; hence PHP is chosen to be the primary language in the system. PHP is open source platform independent and secure language which supports all the major web servers and databases.

The KooKoo PHP API which consists of the methods needed to make and manage an IVR application is used to develop the IVR application and call schematics according to the hospital requirements. The KooKoo API is a simple request and response web API which communicates using an xml based mark-up language called KooKoo Tunes. The requests and responses can be handled more effec-

tively using the PHP library. The IVR application written in PHP is hosted in a publically accessible server, so that KooKoo can use it to relay the call. The calls are initiated by the hospital administration through a local web application which is also developed in PHP. Specific algorithms are used in call scheduling and call processing in order to handle high loads and peak traffic. The SMS gateway of KooKoo is also connected to the IVR application to send confirmation messages and to notify those who do not attend the IVR call. The SMS can be initiated only through the KooKoo PHP API. A chat and e-mail server are setup in-house to allow for the patients and administration to interact. All the communication initiated by the hospital will contain zip code information which will be used by the system to communicate in the patient's native language. The native language feature and call logic have been designed to be able to effectively communicate with illiterate[6] and elderly patients too. Hence the system uses an inclusive design methodology. The inclusive design adds to the advantage of human voice7 that an IVR gives over typical channels like SMS and e-mail.

3. System Architecture

The entire system is divided into two main parts: the admin module which is a web application that initiates all the communications and an IVR application which defines the call logic and SMS communications. The administrative module allows the admin to upload the patient reminder information through an excel sheet. Then the reminder calls can be scheduled in the scheduling page. The call scheduler sends the patient phone number to the IVR platform (KooKoo) which calls the patient with the IVR application module's logic. KooKoo is a cloud telephony platform and the IVR application is a custom logic written to define the voice and features that are provided in the phone call. In the call there are four options: 1. Repeat information, 2. Agree with appointment date, 3. Disagree with appointment date, and 4. Send a feedback through voicemail. The call report with details about the call status, patient reply and other information are stored in call report database. The reminder module checks the call report database to call patients who have missed the reminder call. The administrative module also has a detailed reports page that gives information about all the reminder calls made. The inputs from a call are taken using Dual Tone Multiple Frequencies (DTMF) tones. The SMS feature is implemented using the KooKoo SMS gateway and a chat and email servers are setup in the website to facilitate communication between patients and the administration. The whole system has been shown in the system architecture (Figure 1).

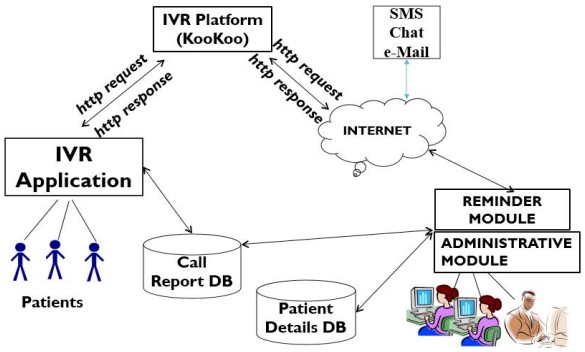

Figure 1. Multi-channel communication system architecture

4. Algorithms

4.1 Call Scheduling

Input: Patient Details from database, Uploaded date
Output:

Receive uploaded_date
Display patient_list
Compute patient_count
while i <= patient_count
Extract the primary contact number and state code
Send number and code to KooKoo
Increment i
End

4.2 IVR Application

Input: Patient contact number, reminder date, state code
Output:

Play introduction audio
play reminder information
Get DTMF Tones from patient
Send DTMF data, sequence_id, call_duration, status

4.3 Call Analysis and Report

Input: Patient call logs, date
Output:

Retrieve call records

```
Read date
Analyse call_record and compute categories
Initialise categories: A,B,C,D
Initialise I = patient_count
retrieve x_i = patient_id
retrieve t_i =
while i<=500
If t_i =0 then A[] = x_i
If 0 < t_i <= 10 then B[] = x_i
If 10 < t_i <= 30 then C[] = x_i
If t_i >30 then D[] = x_i
End.
```

5. Conclusion

Hence the proposed system will increase patient retention and help provide sophisticated care and treatment in and effective manner.

6. References

1. Kempe KL , Shetterly SM , France EK , Levin TR. Automated Phone and Mail Population Outreach To Promote Colorectal Cancer Screening, The American Journal of Managed Care. 2012; 18(7):370-78.
2. Dillmana DA, Phelpsb G, Tortorab R, Swiftb K, Kohrellb J, Berckb J, Messera BL. Response rate and Measurement Differences in Mixed-Mode Surveys using Mail, Telephone, Interactive Voice Response (IVR) and the Internet. 2008; 38(1):1-18.
3. Cohen-Cline H, Wernli KJ, Bradford SC, Boles-Hall M, Grossman DC. Use of Interactive Voice Response to Improve Colorectal Cancer Screening, 2014 Jun; 52(6):496-99.
4. Albert G, Crawford C, Sikirica V, Pharm D, Goldfarb NBA, Popiel MDRG, Wang MDC. Interactive Voice Response Reminder Effects on Preventive Service Utilization, American Journal of Medical Quality. 2005 Nov/Dec; 20(6):329-36.
5. Interactive Voice Response System. Date Accessed: 27/10/2016. Available from: https://en.wikipedia.org/wiki/Interactive_voice_response.
6. Grover AS, Stewart O, Lubensky D. Designing Interactive Voice Response Interfaces: Localisation for Low Literacy Users. Proceedings of Computers and Advanced Technology in Education St. Thomas, US Virgin Islands, 2009, p.1-8.