

Development of an ICT Based Support System for improving Health Care

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Abstract

Implementation of Information and Communication Technology (ICT) in the health sector faces many challenges due to inadequate infrastructure and limited resources. This study has developed a Decision Support System (DSS) which incorporates Interactive Voice Response System (IVRS) to collect information from health workers through their mobiles, software modules to update data from IVRS to Database server automatically and system web site which generates dynamic on line reports from Database server for the perusal of health authorities.

The DSS system is developed using Visual Basic 6.0, SQL Server 2000, ASP, Scripting Languages, Windows 2003 SBS and IIS. Services of Toll Free Landline Telephone Connection, 1mbps Broadband Internet Connection, Static IP, GSM Mobile SIM and SMS Package were taken from Telephone Service Provider. The developed DSS system is deployed at Desert Medicine Research Centre (ICMR), Jodhpur, India. The health workers under Block Pokaran, Jaisalmer, are providing the disease information to the developed DSS system through their mobiles.

The developed model is very fast, cost effective, automatic and flexible over the existing methods of data collection in health sector.

Keywords – Interactive Voice Response System (IVRS), Decision Support System (DSS), Health Management Information System, Information and Communication Technology (ICT)

I. Introduction

Information Technology is increasingly being applied now in all dimensions of health sectors for improving the quality, accessibility and delivery of health care[1][2][3]. However, implementation of Information and Communication Technology (ICT) in the health sector faces challenges in terms of inadequate infrastructure, limited resources and resistance due to lack of awareness[4]. Even after many advances in information technologies, manual reports and registers are the main methods of data collection in health sector in India[5]. As manual reporting does not facilitate any query, sorting, relating etc., there is immense need of an easy to implement information system, which can report and analyze the data in time so as to check for any outbreaks and monitoring[6].

This paper has described a Decision Support System (DSS) which collects information from health workers through their mobiles, update it on Database server automatically with in a minute which in turn is published on website for the perusal of health authorities.

II. Methodology

A Decision Support System is developed which collects disease information from state health workers through Interactive Voice Response System (IVRS)[7][8], sends Short Messaging System (SMS) to data providers, links the data for mapping the disease information on Geographical Information System (GIS)[9][10] and publishes the IVRS data on website.

Development of Decision Support System

The details of the components of the developed DSS are as follows.

(a) Hardware used

- Core 2 Duo CPU with speed 2.0 GHz, 1 GB RAM
- 56kbps PCI Voice/Data/Fax Modem, USB GSM Modem & Broadband Modem
- Microphone, Speakers, Caller ID Telephone instrument

(b) Software used

- Web Server – Window SBS 2003 with IIS
- Database Server - Microsoft SQL Server 2000
- GIS – Arc View 9.1
- Microsoft Visual Basic 6.0

(c) Services used

- Toll Free Landline Telephone Connection, 1mbps Broadband Internet Connection, Static IP, GSM Mobile SIM and SMS Package from Telephone Service Provider

(d) Architecture of the developed Decision Support System

- The DSS is developed by programming a computer to serve as IVR server, SMS system, Database server, GIS system and Web server (Fig.1)
- The telephone line coming from Telephone service provider is passed through a splitter to split telephone line and internet broadband data line. Telephone line is connected to LINE IN port of Voice/Data/Fax modem installed in the Computer system. The LINE OUT port of Voice/Data/Fax modem is connected to Caller ID Telephone instrument.
- The internet broadband data line from splitter is connected to a broadband modem. The broadband modem is connected to the computer through LAN cable. The broadband modem is programmed to forward its port 80 to the computer which creates a bridge between broadband modem and the computer. This enables to host the system website over the broadband internet.
- A USB GSM modem with GSM SIM is installed in the computer.

(e) Program developed for preparing Questionnaire for IVRS

This program module is developed for preparing a hierarchy of questions for IVRS using Visual Basic 6.0 and MS Access as database. The structure of the questionnaire database is described below

Field Name	Description
Mcode	Unique Message Code (Primary Key)
Name	Short Name for the Message
Description	Brief Description for the Message
Wavfile	Name of wave file to be played
Varname	Variable Name to store the callers response
Msg_type	Message Type (predefined options are info or menu or data)
Time_out_msg	Action to be taken if caller delays in responding
Log_yes_no	Either to make entry in log book
b1	Action to be taken if caller presses 1
b2	Action to be taken if caller presses 2
b3	Action to be taken if caller presses 3
b4	Action to be taken if caller presses 4
b5	Action to be taken if caller presses 5
b6	Action to be taken if caller presses 6
b7	Action to be taken if caller presses 7
b8	Action to be taken if caller presses 8
b9	Action to be taken if caller presses 9
b0	Action to be taken if caller presses 0
b_hash	Action to be taken if caller presses #
b_star	Action to be taken if caller presses *

The salient features of this program are

- Each record in the database represents a question with unique message code.
- The field 'wavefile' and 'time_out_msg' contains the link to a pre recorded audio question/ message/menu.
- The field 'msg_type' has the option 'info' (information), 'menu' and 'data'.
- The messages type 'info' is kept for such messages which informs something but do not expect any data or input from caller. For example, 'welcome note', 'thanks note' and 'time out message note'.
- The messages type 'menu' is kept for messages which reads a menu message and waits for the caller to make selection. The variables b0 to b9, b_star and b_hash keep the message code of next question. During IVRS runtime, when caller presses key 0 to 9, * or #, IVRS reads respective b0 to b9, b_star or b_hash fields to jump to the next question. The maximum options for a caller are 0-9, however, the options can be increased by adding sub menus to a menu.
- The messages type 'data' is kept for such messages which reads a question and waits for the numeric data. During IVRS runtime, the numeric data is stored in a variable whose name is taken from the field 'varname'.
- The field 'log_yes_no' has the option 'yes' or 'no'. The 'yes' value instructs the IVRS program to write the buffer into log file during execution.

(f) Program developed for IVRS

The IVRS program module, one of the main components of this project, has been developed using VB6 to interact with callers as per the set questionnaire. Dynamic link library available in VB6 for TAPI 3.0 (Telephony Application Programming Interface) is used to catch the telephonic events. Open source coding for TAPI programming are available at Microsoft Corporation websites viz. www.tapi.info [11] and [ftp://ftp.microsoft.com/telephony](http://ftp.microsoft.com/telephony) [12]. Based on these open source codings, IVRS is programmed according to the requirement of the study.

When IVRS software starts, it checks for the VOICE/FAX/DATA modem (Fig. 2). Then it creates the object of TAPI and initializes it. It then adds TAPI events to the TAPI object. Then this TAPI objects selects the VOICE/FAX/DATA modem for interactive voice response and waits for the TAPI event. When INCOMING ring event occurs, it identifies the caller ID, logs the event and checks if the TAPI object is free or not. If TAPI object is found busy it rejects the call otherwise it accepts the call and reads the record in the questionnaire database where field *msg_code*=1.

The IVRS plays the audio file given in field *wavefile* (Fig. 3). The IVRS then checks the field *msg_type*. If *msg_type*='info' then IVRS automatically jump to the record with message code as defined in *b_hash* field. If *msg_type*='menu' or 'data' then IVRS waits for the caller's response.

When caller responses by pressing any telephonic key during IVRS questionnaire session, a Dual Tone Multi Frequency (DTMF) event occurs, IVRS identifies the telephonic key pressed by the caller, logs the event. If field *msg_type*='info', IVRS takes no action. If field *msg_type*='menu', IVRS jumps to the record with message code as defined in the field b0 to b9, b_star or b_hash depending upon the callers response. If field *msg_type*='data', IVRS accepts the numeric input into a variable until caller presses '#' key. The IVRS concatenates the variable name from field *varname* and collected data into a global string variable in comma delimited format. Then IVRS jumps to the record with message code as defined in field *b_hash*.

If a caller delays in responding the program, IVRS moves to the record with message code as defined in *time_out_msg* field. If a message record contains 'yes' in the field *log_yes_no*, IVRS logs the value of global string value into a log file.

IVRS Server is programmed to create and maintain three log files. The CALL LOG file keeps the record of the calls received by the IVRS. The INTERACTION LOG file keeps the record of the internal events of the IVRS, the incoming call detail, the sequence of messages played by the IVR, every response made by the caller and the action taken by the IVRS. The FINAL LOG file records the answers responded by the caller in a comma delimited format. The developed log books are placed in a web folder, which enables the authorized user to view these files remotely through internet.

(g) Program developed to transfer data from log files into SQL server

The program module has been developed using VB6. This software extracts the data from IVRS FINAL LOG files periodically and puts it into SQL server database.

(h) Development of DSS Web site

The DSS Web site has been developed using Active Server Pages, Java Script and other scripting languages. The IVRS data stored in SQL Server database is linked with the web pages. This web site enables the data users to view/ edit/ analyze the data received through IVRS.

(i) Program developed for sending SMS

The SMS program module has been developed using VB6 to send SMS through USB GSM Modem to acknowledge the callers and inform data users. "Microsoft Communication Control 6.0" component available in VB6 is used for communicating with USB GSM Modem. Open source coding for SMS programming in PDU format are available at website <http://www.developershome.com/sms> [13] and <http://www.scampers.org/steve/sms/samples.htm> [14]. Based on these open source coding, SMS system is programmed according to the requirement of the study.

The developed software periodically creates text SMS from the IVRS database, encodes the SMS into PDU format and puts this SMS into a queue. Another software module sequentially sends these SMSs from the queue through the USB GSM Modem.

(j) Linking of GIS System

The maps of the study area have been prepared manually on GIS. Each polygon in the map is assigned a unique location code. The location area in IVRS database is linked directly with location code of GIS map of study area and thus IVRS information is mapped easily on the GIS map of study area.

(k) Data Validation and Correction

While developing questionnaire, after a gap of 3 to 5 questions, a question asking total of earlier questions was added. These questions have served as check point for the validation and correction of data. The IVRS data was verified through website by matching actual total of the data with the total asked in IVRS questionnaire.

IV. Result and discussion

The DSS system is developed using Visual Basic 6.0, SQL Server 2000, ASP, Scripting Languages, Windows 2003 SBS and IIS. Services of Toll Free Landline Telephone Connection, 1mbps Broadband Internet Connection, Static IP, GSM Mobile SIM and SMS Package were taken from Telephone Service Provider. The developed DSS system has been deployed at Desert Medicine Research Centre(ICMR), Jodhpur, India. The health workers under Block Pokaran, Jaisalmer, are providing the disease information to the developed DSS system through their mobiles.

The program modules transferred the IVRS data from log files to SQL server within a minute. The IVRS data was verified. 8% of the total calls received by the IVRS were rejected due to validation failure. The IVRS log files are found to be very helpful in identifying the technical errors and the human errors. It is observed that initially the callers made mistakes but soon they got familiarized with the system. The SMS system acknowledged the callers.

Results demonstrated that IVR technology can be applied in health sector for disease information collection reliably. In abroad IVR technology has been used for health surveys, reminder, monitoring of alcohol consumption and diabetes control etc[15]. In India, IVR technology is being used in commercial sector but the use of IVR technology for health research is quite less. However, communication technology is being used in some studies. In a study in the Mallapuram District of Kerala, handheld devices were used to collect health data from field[16]. The Center for Development of Advanced Computing (CDAC) is developing a 'Mobile-Based Primary Healthcare Management System' to strengthen primary health centers in both rural areas and urban slums in India[17].

This study is not a survey. In this study, the system has been developed for the existing health functionaries and is an attempt to develop a real time health management information system.

V. Conclusion

The developed model has many advantages over the existing methods of data collection in health sector. The system is very fast and easy to implement. It is cost effective as it doesn't involve the expenditure of computerization and skilled workers at root level. It has no distance hindrance as it depends on telecommunication. The questionnaire developer software is capable to create as many menu items as required. The questionnaire is flexible, as it allows to add/ edit/ delete a question. The audio files for a question can be developed in the desired regional languages.

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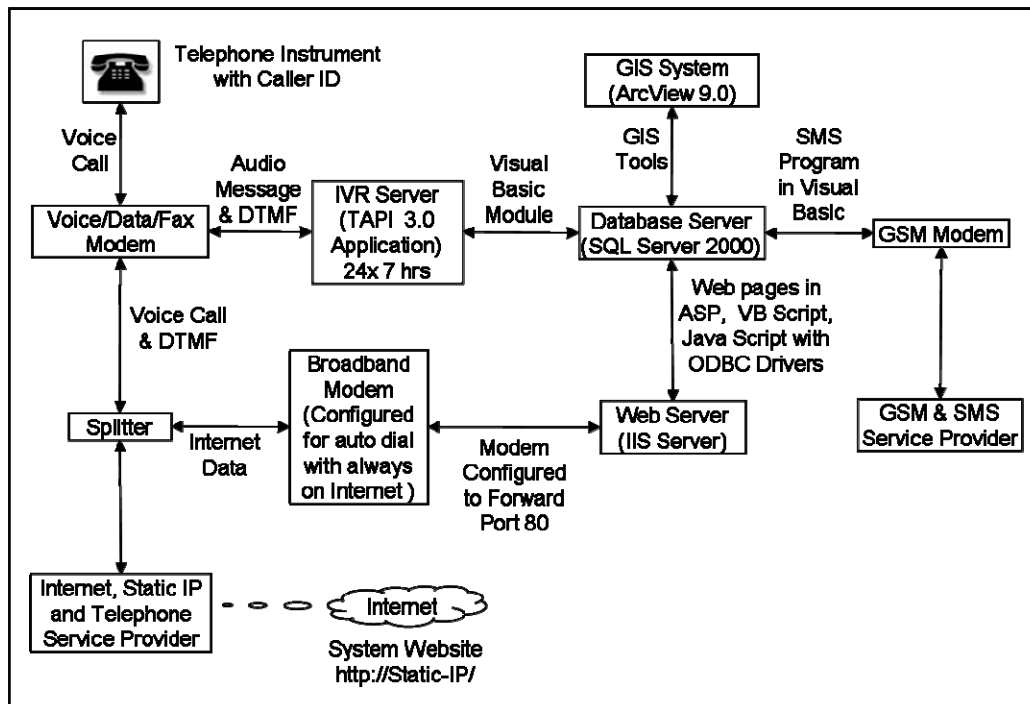


Fig. 1 : Architecture of Decision Support System

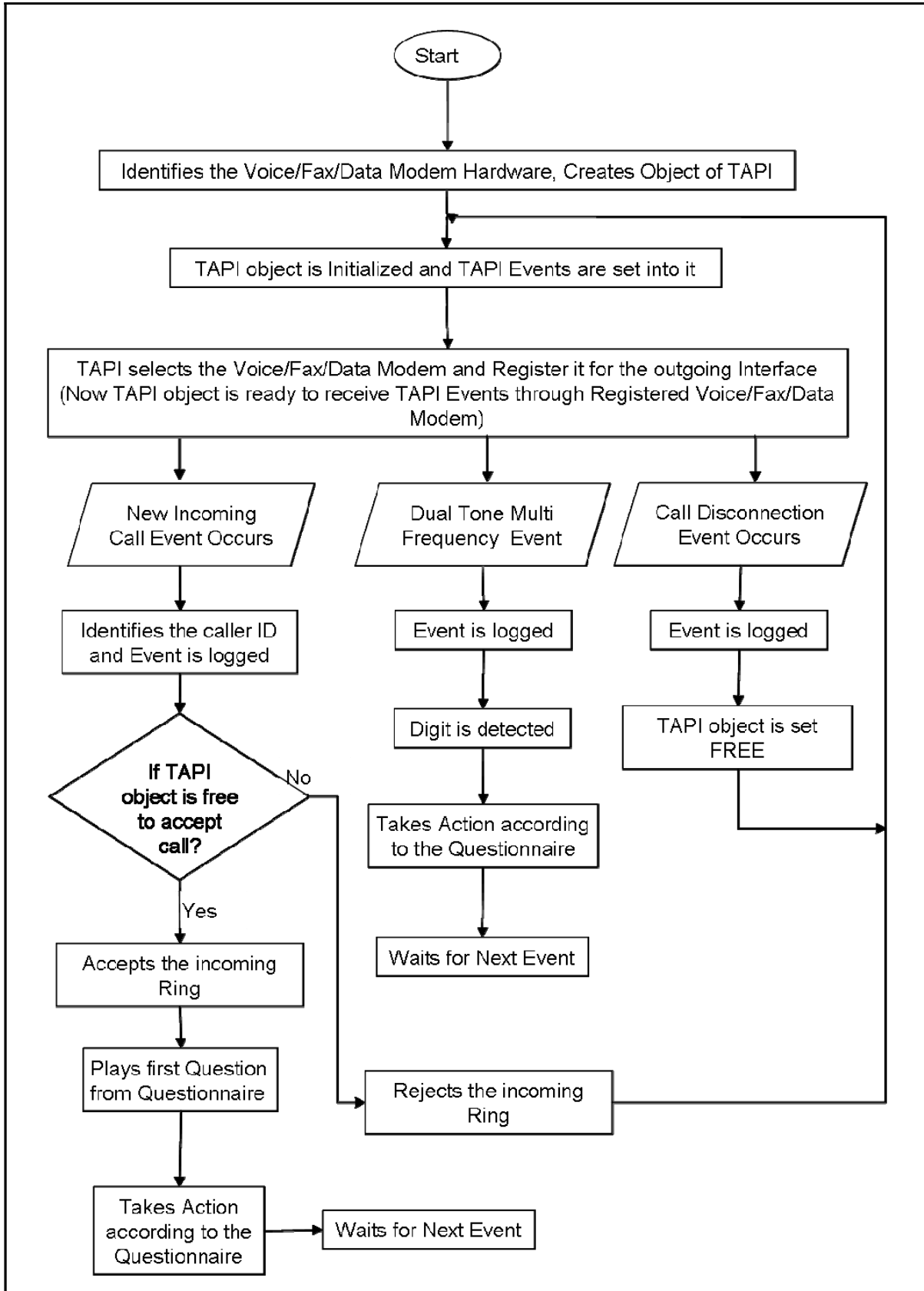


Fig. 2 : Flow diagram of IVRS event handling software module

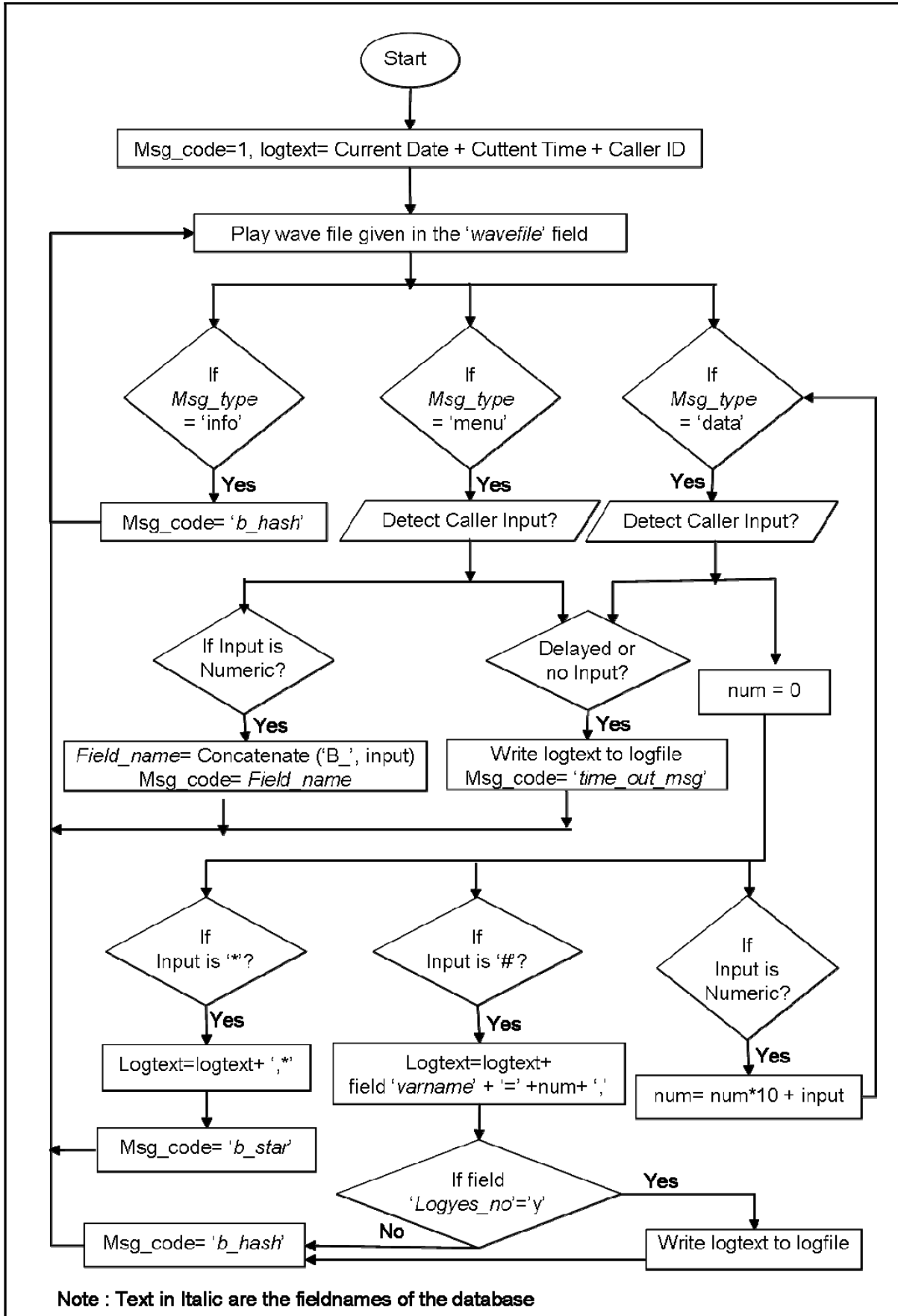


Fig. 3 : Flow diagram of IVRS questionnaire handling software module

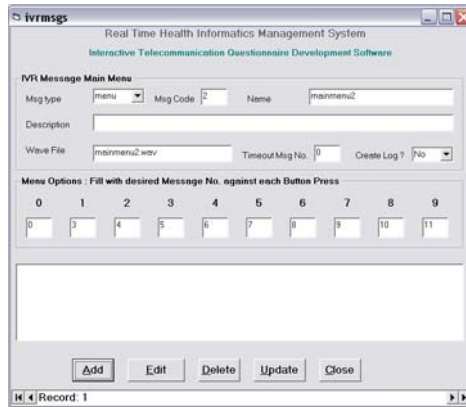


Fig. 4 : Runtime screenshot of Questionnaire Developer Software

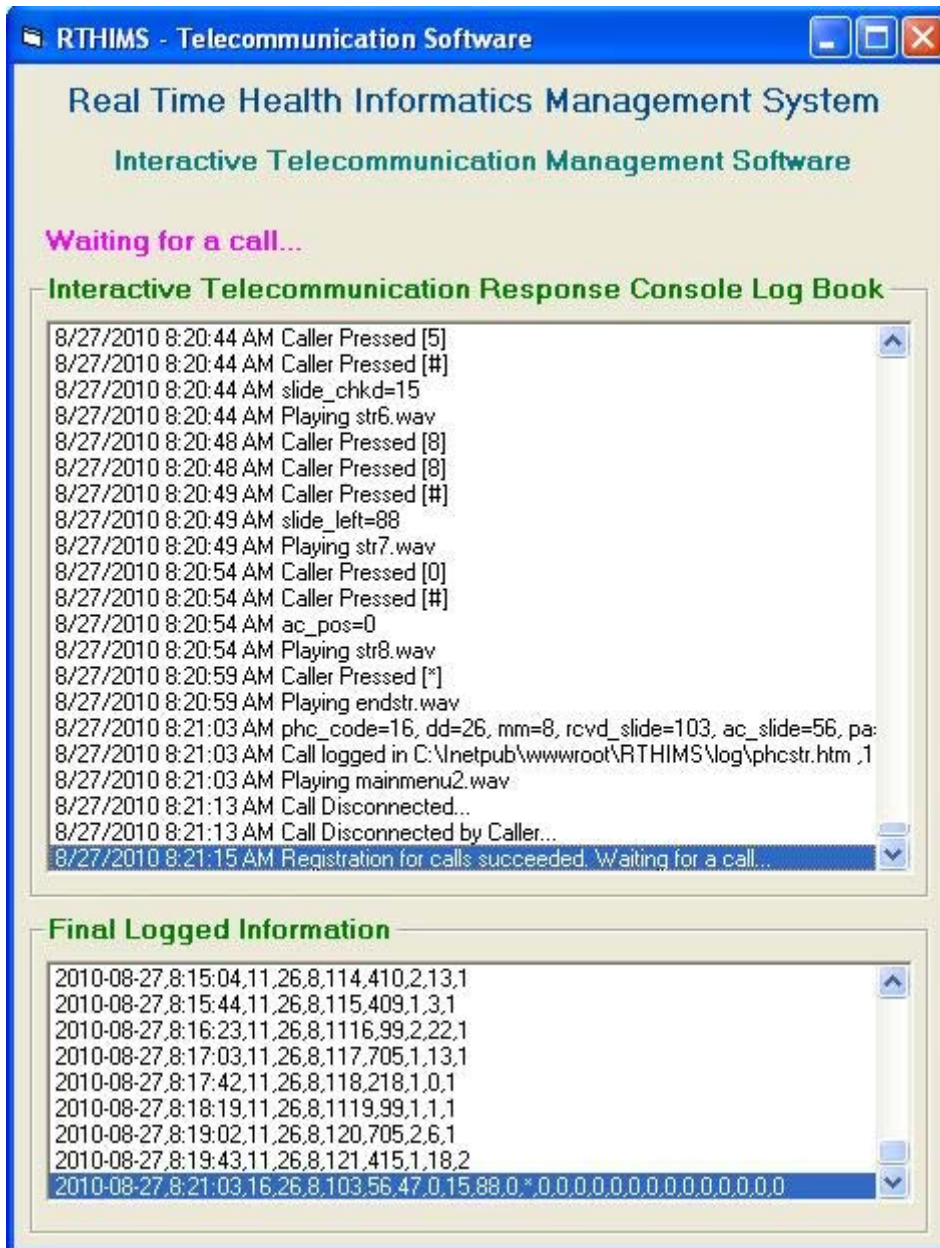


Fig. 5 : Runtime screenshot of IVRS Software