

Intelligent Interface Based Speech Recognition for Home Automation using Android Application

M.Tharaniya soundhari, Ms.S.Brilly Sangeetha

tharaniyam@gmail.com, Brillyvino82@gmail.com

Abstract

The home automation system plays an important role in maintaining living standards and provide secure and flexible environment. The aim of this project is to design a home automation system which makes operating of electrical appliances in home through android application. The home automation system allows controlling of home appliances by using voice commands by recognizing the input speech. The speech recognition is done by Support Vector Machine. The home automation system is implemented wirelessly using General packet radio service (GPRS) technology. The electrical appliances such as fan, light switches, light sensors, current sensors are integrated in a system which then connected to microcontroller which act as a within the home to control and perform the user commands

Index terms: Home automation, Android application, speech recognition, GPRS, SVM.

I. INTRODUCTION

The home automation system improves the living standards and also helps the elderly people. The ability to control the electrical home appliances not only from one location but throughout the country is a promise of home decades. . The wall switches located in different parts of the house makes the user difficult to go near them to operate. Even it becomes more difficult for the elderly and physically handicapped people. The home automation system implemented wirelessly using GPRS technology, is able to control electrical appliances without limiting the range. As technology is advancing the home automation system are also getting smarter. Modern houses are mostly shifting from switches to centralized control system, which involves wirelessly controlled switches. Real time based Remote control home automation system provides an easier solution with Android application technology[1],[2]. Android is a software stack for mobile devices that includes an operating system, middleware and key applications. Android consists of connectivity options, including

Wi-Fi, Bluetooth, and wireless data over a cellular network. Android provides access to a wide range of useful libraries and tools that can be used to build rich applications. In addition, Android includes a full set of tools which provides the developers with high productivity and deep insight into their applications. Remote operation is achieved by any smart-phone/Tablet etc., with Android OS[1],[2], upon a GUI (Graphical User Interface) based touch screen operation. In order to achieve this, Android application act as transmitter, which sends ON/OFF commands to the receiver where loads are connected as shown in Figure.1. By operating the specified remote switch on the transmitter, the loads can be turned ON/OFF remotely through wireless technology.

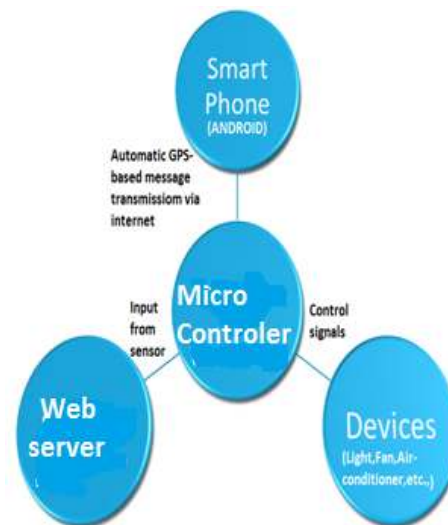


Fig.1. Home automation system processing

1. The android application sends the voice command to the micro controller which is received from the user.
2. The micro controller receives the voice command as an analog signal and converts it to digital signals.

3. The converted digital signal is send to a web server.
4. The web server receives the digital signal as a voice command and makes a context search in the database and performs the action.

In home automation system the speech processing has increased[1],[2]-[3]. To maintain the natural medium of communication the home automation employs a speech recognition system which is capable of analyzing the user language and extracts the commands. The Support Vector Machine is used to classify the speech from the set of observations[3]. In this method the user is able to communicate with devices easily with anytime, anywhere functionalities. The functionalities such as device ON/OFF, the user can control devices without limiting the range in environment. The speech as a command from the user is taken as an input and is matched with the predefined sets in the database which is stored in the PC, act as a server. The keyword mapping is performed (Fan ON/OFF as a keyword is matched with same word in database). If a match found the action is performed. The SVM classifier is used to recover the original source from the mixed noises as soon as the command is received from the user[3].

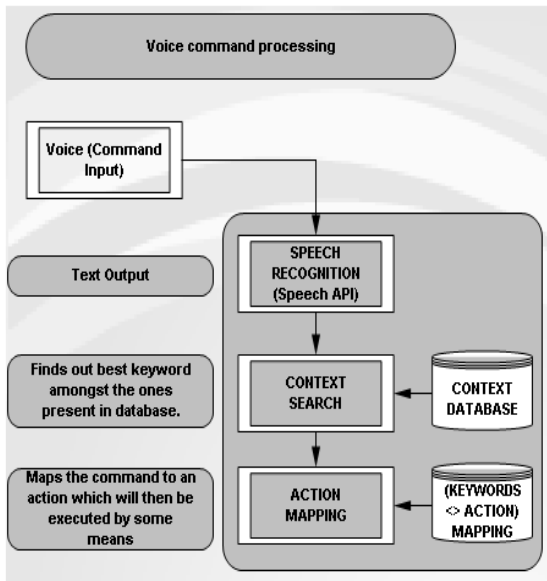


Fig.2. Speech recognition using keyword mapping

The home automation system integrates the home electrical devices and it is connected to the microcontroller. It coordinates various actions and

controls multiple devices. The PC which acts as a server is connected to a microcontroller. Several sensors such as analog to digital conversion sensor, light sensors are used to convert analog to digital signals for server process. Android application has a controlling for security and for device turn ON/OFF .It can control multiple devices as Device1, device 2, device3 etc., Based on the GPS location provided by the android phone the actions are performed. The speech recognition engine works according to the command which is given by the user .It removes noises from the original source and makes a context search in the database and performs the desired actions.

This paper presents our research and contribution to the speech recognition based home automation system .Section II presents the results of related work in analyzing wireless networks for home automation .The project is divided into Four parts. The first is to develop the web server application which is to connect the hardware devices and microcontroller. This step is described in section III. The second part is to develop the android phone application which serves as an interface between user and a server to feed the commands and instructions which is interpreted on the server and the appropriate action is taken. This part is described in section IV. The next part is to discover an IP address to connect a server to an internet. This is step is described in section V. The last part is to monitor and control the home appliances. Finally in section VII results are discussed.

II. RELATED RESEARCH

The home automation system is designed using various technologies such as Bluetooth, Zigbee, Internet, short message service (SMS) based. These latest technologies give user friendly home automation system with low cost. The capabilities of Bluetooth are good and current cell phones, laptop, tablets have built-in-adapter that will indirectly reduce the cost of the system. However it limits the control to within the Bluetooth range of the environment [2],[4].

Zigbee based home automation systems are used. Zigbee in home automation reduces the cost of wiring and provide reliable and secure communication [2],[4],[6]-[7]. The early sensor networks were used with Routing Algorithms and RF technologies. The recent system have been using standard-based algorithms and RF solutions.ZigBee is considered as a low data rate wireless network standard as shown in table:1,with added features like low-cost, low power

consumption and fast reaction and it is most suitable for small area networks.

WIFI based home automation system uses PC based web server which connects the home devices. The system also supports a wide range of home automation devices like power management components (electrical appliances), and security components (alarm systems). The drawback is that many devices will need to be connected to power sources, and in that some devices such as automated power outlets and need sufficient electrical power sources.

There are some challenges in designing home automation using wireless sensor networks (WSN): Single Point of Failure, scalability, Hop-by-Hop, End-to-end. The home automation system can be implemented using three alternative approaches: GPRS, Speech and Internet. The GPRS technology used to control the signals without limiting its range. Speech is used to process the specific user commands to perform Different switching and control systems by giving the voice signals [4],[5]. A significant contribution to home automation system is made by using the above mentioned systems. The remotely accessible home automation system is made by using Database, web server, speech recognition program and control program. The PC is used as a server that reduces the cost and power consumption while others require web page hosting that adds up the extra cost. The voice recognition systems either use PC software or separate voice recognition module for speech recognition[5]. In proposed home automation system the speech will be recognized using Support Vector Machine (SVM) classifier and activity detection by using keyword matching algorithm[3].

III. SYSTEM DESIGN

A. System architecture

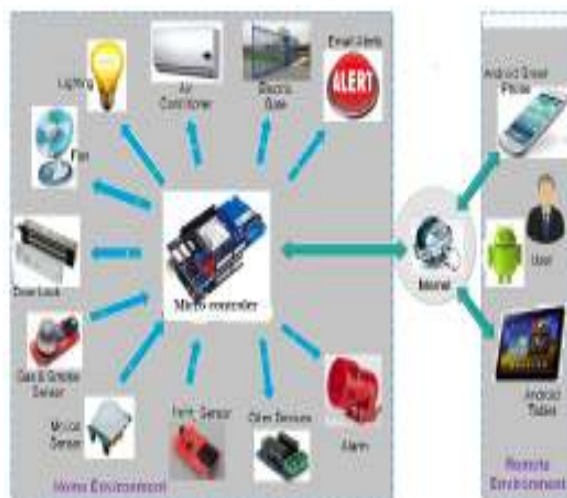


Fig.3. Overview of home automation system

The overview of a home automation is shown. The system consists of an android developed application which controls the home appliances [8],[9]. The system consists of the micro controller in which electrical appliances are directly interfaced to the microcontroller. The home automation system is controlled and monitored from the remote location using Android Smart Phone. The android phone communicates with the web server through internet and sends the signal to the microcontroller which acts as hub in the home automation system. Any internet connections 3G network or 4G can be used on the used Smart phone device. The features of home automation includes

1. Controlling energy management devices such as lights, fans
2. Voice activation is used for switching functions.
3. Provides security by having user authentication to accesses devices

B. Software development of android application

The smart applications can be developed using several platforms such as Android, Windows, Symbian, iPhone. The application for home automation system is developed in android phone. Java programming language with SDK (Software development kit) is used to develop the applications. SDK is a set of software development tools which allows to create the applications for a certain of a software package, software framework, hardware platform and computer system or similar development platforms. Eclipse which runs on Windows 7 platform officially supports integrated development environment (IDE) which is used as conjunction with ADT (Android Development Tools).

The designed app for the home automation system provides the following functionalities to the user:

1. Remote connection through internet to the web server.
2. Provides IP and user authentication.
3. Controlling and monitoring of home appliances.
4. Scheduling tasks and to control of the home automation system.
5. Password change option.
6. Provides voice activation for switching functions.



Fig.4.Screen shot for the home automation system

IV. SOFTWARE DEVELOPMENT OF THE HOME AUTOMATION WEB SERVER

The web server is developed to connect the hardware devices and the microcontroller. By using the stream socket connection the android mobile application is connected to the web server. The desktop IP address is given in the mobile application and then connection is established. Jar file is created using J2ME wireless toolkit & installed into the android phone through the USB port.

The web server is developed and is connected to the microcontroller acts a heart of the home automation system. The microcontroller with web server is connected to the internet through TCP/IP which act as a both client and server for the home automation. The output message which sent to the android application is in JavaScript Object Notation (JSON) format. Through the http settings the system can easily catch the commands from the real address. The data flow diagram of home automation is shown to describe the general processing of the home automation system.

The user enters the IP address and the password in android application. If a password is valid it monitors the device status and respond back

to the user whether the specific device is ON/OFF as shown in Figure 4.If a user wants to turn of the device user sends a voice command through android phone to the microcontroller which converts digital signals and transmit the signals to the web server. the web server makes a keyword search in the predefined database and performs the action. The server which is connected to the micro controller performs the operation .Once the actions starts the sub-routine is called and the pasword Is verified.If a password is valid the authentication is provided and the action is performed. after performing every action the output is sent to the client.If a client makes a request to cahnge a password by clicking password change button then the new password is changed in the memory and it is initialized.

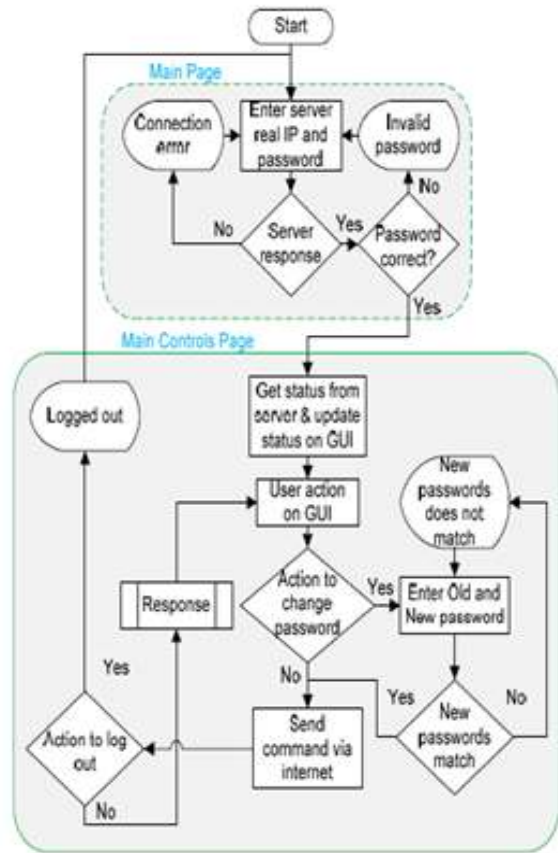


Fig.5.Processing of home automation system.

\$	Password	\$	Device	_	Action
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Fig.6. General Layout of user command

V. ADDRESS DISCOVERY FOR WEB SERVER

To successfully connect and access the web server in the home automation system the user has to enter the real IP address. If a web server grant access to home automation system the command containing the response code is received. The android application process the command to determine the web server's response. The code indicates that the IP address is correct and it switches to the micro controller as shown in Figure 5. and synchronize using data from the command. If a password is invalid the code 404 will be received. Once the access is granted the user can perform the action by using speech recognition engine switching functions can also perform with voice activations. When the user performs the actions on home automation system command send to the web server through the internet. The general command is shown in Figure 6. the command is designed in a way such that the web server can easily read extract the command.

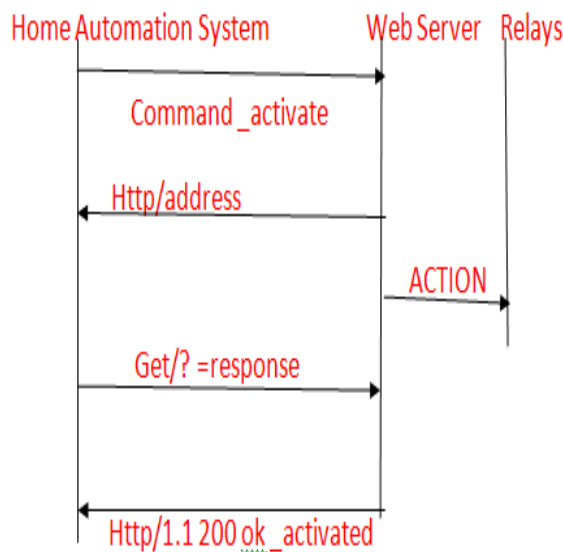


Fig.7.Exchange of message between android application and web server to process the command

VI. MONITORING AND CONTROLLING HOME AUTOMATION

The home automation system is controlled and monitored using android application wirelessly. The user gives a voice command in the android application. The smart phone send the command to the web server through internet. The web server

verifies the IP address and response back to the user as valid password. The server send the command to the micro controller, it converts analog signals to digital signals. voice command is extracted using Support vector machine classifier. SVM classifier extracts the original sources from the noises. The original source is extracted using background subtraction. The keyword matching algorithm is performed. It matches the command with the pre-defined sets in the database. If a keyword is matched then the specific action is performed.

For example if a user gives a command to switch ON light (Light ON) the command is processed and the keyword (Light ON) is matched in database and the action is performed. The main purpose of this project is:

1. Controlling home appliances wirelessly through mobile phones.
2. Usage of speech recognition application for performing the task.
3. Internet based wireless transmission using android 3G network.

This home automation system provide the exposure to the following technologies such as using android open source technology, Interfacing PC to the Microcontroller, Electromagnetic Relays are used for switching principles, Interfacing of Relay board to Microcontroller to communicate with the hardware devices, Embedded C programming to perform controls in the automation system.

VII. EXPERIMENTATION AND RESULTS

The implementation of the home automation systems is to monitor and control the home appliances. The home automation system is fully functional for switching applications and the home appliances are switched on the user interface is updated to reflect the current status. The home automation is designed with security features such as user authentication for accessing the home automation system. The low cost home automation is designed to control the devices remotely by using keyword matching which is shown in Figure.2 for activity detection and SVM Classifier for speech recognition.

The set of activities are determined to classify automatically. The activities such as the control of lighting, air conditioner, and fan digital to analog conversion sensors, light sensors. The implementation is based on Keyword matching, Speech recognition using SVM classifier, Control signal program (CSP).

The experimentation is performed with several controlling activities (Light ON/OFF, Fan ON/OFF, and Air-conditioner ON/OFF).The speech recognition is performed with different sounds bell ringing, speech sounds.The SVM classifier classifies clean audio files from original sources.

Table 1

Performance analysis of proposed home automation system

Sound class	Mixed sounds	Separated sounds (Baseline)	Separated sounds (Proposed system)
Background noises	0.08	0.60	8.80
Door bell ringing	0.23	0.75	0.78
Human speech	0.24	0.00	0.96

DISCUSSION AND CONCLUSION

This paper presents the study of internet based home automation system which can be controlled remotely and for security user authentication is proposed .The Intelligent Home System is a voice-controlled home automation system which controls home appliances using android application over a wireless network. Voice controlling enables users a sense of comfort as no direct operation with the home automation system is required. The Android based home app communicates with the micro web-server via internet using the web service. Any android supported device can be used to install the smart home app, and control and monitor the smart home environment. A low cost smart home system has been developed in which all processing is handled by the microcontroller. The proposed system reduces the wiring by using wireless networks.

The sound classification gives the preliminary results with good classification rate of 96% by using SVM classifier with the given parameter. The classification rate is different for each sound. The proposed system gives the highest rate which is represented in the database.

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