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Control Electronics with Your Voice Using Bluetooth-Based Spoken Queries

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Abstract :***This paper discusses a spoken query system developed for accessing some household electronic devices.The developed system enables the user to access these devices remotely by calling the system using a GSM modem/Mobile phone. The spoken query system has mainly two modules i.e. interactive voice response (IVR) andautomatic speech recognition (ASR) modules, which can be developed using open source resources. In thedevelopment of ASR models, the system specific data are collected from people of different ages and genders. Theissues of data preparation, Training and Testing are performed by using HTK as a speech recognition tool. Thesystem can recognize sample data i.e. the voice commands independent of vocabulary size, noise, and speakercharacteristics. The recognized voice command as a text file will be used as an input into themicrocontroller that isresponsible to control the electronic home appliances. This speaker independent interactive voice response system isbased on HMM (Hidden Markov Model) which is found to give arelative improvement of accuracy by more than50%***

Keywords - IVR, Speech, ISR, HTK, Training, Testing, HMM

INTRODUCTION

in today's modern era, home automation is becoming acrucialareainresearchasinformationtechnologyisgrowing so rapidly from the computing to communication.As we know, the speech is a special kind of communicatoramong all human beings for their communication, that iswhy in this work, research is aSpeakerindependentspeechmodulewhichcontrolselectronicdevicesbythevoiceofhumanbeingsi.e.communication between man and machine. At the presenttime, people want to get comfort as well as easyand.Solotsofhomeautomation system controlled by different communicationmechanism is introduced to ease the daily life of humanbeing. But most these systems are not convenient, energyefficient,andsafetyinrealtime.Therefore althoughseveral development leading to Automate the electronic orelectrical devices over wireless already developed, but inthis work a special focus has been given to introduce voicein terms of speech not only for a natural communication,also for the communication between man and machine. Inthisentirework,anuserfriendly spokenquery systemconsists of interactive voice response (IVR) automaticspeechrecognition(ASR)modulesisdesignedforcontrolling some household electronic devices. It is easyand cost effective to integrate the telephone network withautomatic speech recognition (ASR) system. As a resultdeveloping a spoken query (SQ) system for accessing theappliances this system appears as more speaker.Thedesignedsystemisawrappingoftwomodulescontaining a SQ (spokenquery)system and

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ahardwareinterfaceconnectedtotheelectronicdevices.Thedevelopedspokenquerysystemagaincontainstwodefinitemodulessuch as an interactive voice response (IVR) andan ASR system based on Hidden Markov Model (HMM)which are developed using open source resources. In thedevelopment of ASR system, controlling oriented ages including male and female using the sameIVR module. The hardware interface is responsible to takethe voice command in terms of text content and switchingtheelectromagneticrelaywhichcontrolsthe electronicdevices. The core of this hardware module is low-powerconsuming, but high-performing AT89S52 Microcontrollerwith programmable flash memory

SPOKENQUERYSYSTEM

The Spoken query (SQ) system is developed to providespeakerindependenthomeautomationsystem.TheSQsystemconsistsofaserverrunningAsterisk,an ASRsystemandacontrollinginformationdatabasefor allelectronicdevicesconnectedtothesystem.Asterisk isopen source software on Linux/Unix platform that enablesin connecting the server to the telephone network[4]. TheAsterisk server consists of an Interactive Voice Responseand a computer telephone interface (CTI) card. The CTIcard is connected to the integrated services digital network(ISDN) primary rate interface (PRI) digital line Devicessuch as IP phone, mobile phones or landline can access theAsteriskserverthroughtheISDNPRIline.Inourdesigned system,amobilephoneisusedtoaccesstheAsteriskserver through the Bluetooth line. The developed systemenables the user to make a query to control the devices andcheckthecurrentstatusofthedevicesthroughapre-recordedvoiceresponse.Thesystemquerysysteminteractswiththeuserwithauserfriendlycall-flowconsisting of two major parts. In the first part, the user ispromptedtoutterelectronicdevicenameandthenthe system will inform the present status of devices and waitfortheusers'utterance.TheblockdiagramofourSQsystemisgiven inFig.1

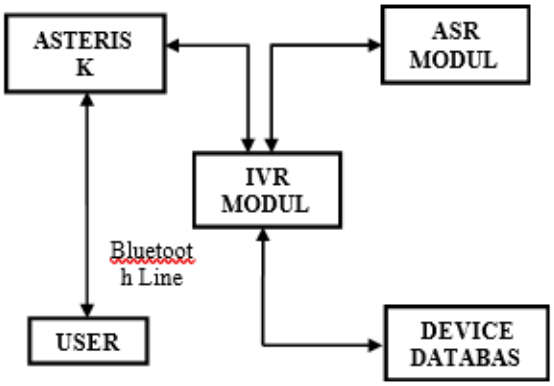

Fig. 1–BlockDiagramofSQsystem

DeviceControllingDatabase

Inthissystem,alltheinformationregardingtheeachand every operationsperformedon electronic devices shouldbe stored for the further uses by another user. To serve thispurpose, the MySQL database management system is used.The device controlling information is updated using thisdatabase. The query from the user is used to retrieve thedevice present information that is stored in the database.Thestatusandnamesofthedifferentdevicesaredisseminatedthroughthepre-recordedvoicecommands.

METHODOLOGY

Theproposedsystemisanautomationsystemforcontrollingdevicesconsistsoftwomainmodules,thespeech recognizer server and the hardware interface. Usercommands are transferred to the home automation servervia speech recognizing system. In the home automationservertheincomingcommandsareprocessed,thendigitized andsentto therelevantunittobeprocessed.These hardware units have also the capability of sendingtheir status back to microcontroller which is connected tothe home

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automation server thus they can be monitored inreal time. After receiving the feedbacks from the appliancenodes,thehome automationserverinterpretsthem andperformsthe necessarytasks.

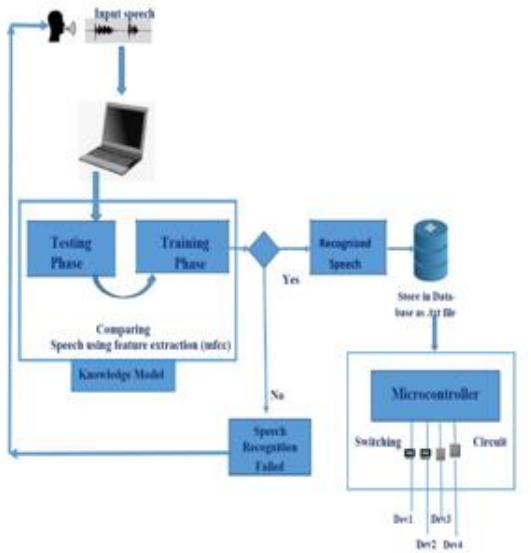

Fig. 2 – Proposed Framework of the system

InputSpeech

In our proposed system we use speech as command forcontrolling electronic device. Therefore we have collectedour required voice data from different people in differentenvironment.For collectionour required data,we haveusedmicrophone and wavesurfer as avoice recordingtoolkit. We have tried to avoid the noise in our recordingenvironment. Still in our collected data, we found somenoisysamples.Dependingonnoisyutterance,we haveignoredsuchsamplesforfurtherprocessing.Weh avesaved all voice data in .wav file extension with 16000 bitrate. Collection of voice data for speech recognition is verychallenging because the accuracy of recognition dependson this collected input speech as well as collecting trainingdata

Testingphase

In testing phase the system collect voice command frommicrophoneorstoreddatabase.Thevoicecomma ndscollected from microphone are saved into database in .wavfile extension. Then speech recognizer verifies the voicedata by feature extracting using MFCC. Then the extractedMFCCofvoicedata forwardtrainingphase

TrainingPhase

An HMM-based system, like other speech recognitionsystems, functions by first learning the characteristics of aset of sound units, and then using what it has learned abouttheunits tofindthemostprobable sequenceofsound units fora givenspeechsignal.Theprocessoflearningabouttheso und unitsis calledtraining

RecognitionPhase

After training and testing phases completed, our processgoes through a recognition process. As mention earlier wehave used HTK as recognition tool. We have trained ourcollecteddatainHTKtrainingphase.Againwe havestoredsomesamplesastestingdatainour databaseinHTKdecoding phase. When we give test file in decoding phasethenHTKwillcomparethetestingsamplewith thesamples that are trained in HTK training phase. If the testfile matches then the recognition will success and then therecognition samplewillgotothemicrocontroller

IMPLEMENTATION

Asmentionedtheproposedframework,theimplement ation of designed system is depend on mainlytwomodules.Thefirstoneisspeechrecognition andanother one is hardware interface for controlling Devices.The speech Recognition module consists of different sub-modulessuchasdatacollection,datapreparation,exec ution etc. The hardware module provides an interfaceto get the recognized command that are to be used fordevice controlling by using a microcontroller, heart of theswitchingcircuit.

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DataCollection

Wehavecollectedthree commandsasword“LIGHT”,”FAN”,“REFRIGERATOR”,”TV”,”MOTOR”,“ON”,“OFF”, “STATUS”) from 200 people out of whichapproximately140recordingsareofmaleandapproximately 60 recordings are of female speakers. Thedata is recorded with the help of unidirectional microphoneusingarecordingtoolwavesurferin.wave xtension.The .wav files recorded are saved transcription. The samplingrate used for recording is 16 KHz. A labeling tool wavesurfer is used to label the speech waveforms. The labelfiles are used in acoustic model generation phase of thesystem. Following are the command words that we havecollected

Serial No.	Command
1	LIGHT
2	FAN
3	REFRIGERATOR
4	TV
5	MOTOR
6	ON
7	OFF
8	STATUS

Table-1- Required voice command word

PhoneSet

Phoneme is the basic or the smallest unit of sound in anylanguage. In the phone set that we have used to develop thespeechrecognitionsystem,thephonesetconsistsof 8phonemes.A list of all the phones that are being used and saved asfilename.phone is prepared. Here the entries of the phonelist will be light fan Refrigerator Tv motoron offstatusSIL.

HardwareInterface

The hardware interface along with a microcontroller, aLCD and a relay driver is responsible to get the recognizedcommand and control the devices according to the voicegiven by the user. For managing the microcontroller wehave designed and compiled a program using embedded cinkeil4.0compiler.Afterthatwehaveburned theprogramintothemicrocontrollerby usingflashmagic.After training and testing, the recognized voice should beput into the TTY USB port so that our microcontroller canreadandaccessthevoiceandcanhandlethedevices

SpeechReorganization

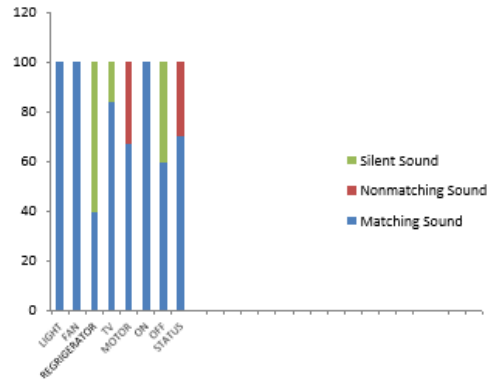

Figure3:Bardiagramofanalysisv/srecognition words

Inthissystem,databaseconsistsof8differentwordsLIGHT,FAN,REFRIGERATOR,TV,MOTOR,ON,OFF and STATUS. Our speech recognition systems consist oftotal 1000 utterance words taken from different speaker.Including these words we have taken 880 utterance wordsfor training, which are spoken by 200 different users andtook them as a trainee in training phaseby recognitiontoolkit.After completion of their training wehave testedbynewutterancewordsbythenewinputdifferent speakers.We took 120 new utterance words from newspeakers. After testingphase is completed, we have

comparedthetrainingandtestingphase.Thenwehaverecognizeddifferentkindsofsoundsasmentionbelow:

- Matching sound: These are the sounds used in thetrainingmodelwhichmatchwiththetestingsounds.

- Non matching sound: These are the sounds used in thetraining model which do not match with the testingsounds.
- Silencesound:Thesearethesoundsusedinthe trainingwhich donotshowanyoutcome.

CONCLUSION

The development of a speaker independent spoken querysystem for accessing the household electronic devices isdescribed in detail in this work. In this system, we usespeechasthemaincommunicatingmediabetweent hemachine and the human beings. It has been discovered thatthere are many people who have a computer phobia. Thereasons why many people fear to use speech recognitiontools have been due to the inadequate user interfaces. TheHTK was used for the implementation of the recognizer.HTK was used because it is open source, more accruableand has been used by many researchers all over the world.A limited grammar and dictionary were constructed to beused by the recognizer. The Speech data was recorded andlabeled from 200 different speakersmaking the trainingand the testing corpus. We have also explored a set of datatomakethesystemmorespeakerindependentwith agradual improvement of accuracy from more than 50% ofpresent time.

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