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Design of a Voice Based Intelligent Prototype Model for Automatic Control of Multiple Home Appliances

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ABSTRACT

The revolution in Information Technology(IT) and Artificial Intelligent has provided innovations in diverse kinds of home automation where appliances can be controlled effortlessly and seamlessly .In this paper a review of several home automation technologies was presented and the advantages voice based technology was considered trending among other technologies in terms of flexibility and cost and comfort. In this paper, the conceptual prototype design model and the circuit diagram for controlling multiple home appliances at the same time were presented. The model uses Arduino Uno microcontroller system to control multiple home electrical or electronic appliances with maximum of 5 volts. The design transmits voice command through user wireless microphone (attached to the user cloth) to the intelligence micro controller via graphical user interphase (GUI). The control software developed for the prototype model was implemented using C# programming language, Microsoft Visual Studio.Net and Microsoft Speech recognition system.

Keywords: Home Automation , Artificial Intelligence, Arduino Uno micro controller, Prototype Model

1 Introduction

The revolution in Information Technology (IT) and Artificial Intelligent has provided innovations in diverse kinds of home automation where appliances can be controlled effortlessly. Home Automation Technologies, is the controlling and monitoring of home appliances in a unified system. These include lighting, heating, and even home electronics. This automation systems range from simple remote control of lighting to complex computer/micro-controller based networks with varying degrees of intelligence and automation. Home automation is adopted for reasons of ease of control for all categories of users, security and energy efficiency by the use microprocessor-based intelligence to integrate or control electronic and electrical devices and systems in the homes such as fans, lights, air conditioners, television sets, security cameras, electronic doors, computer systems, audio/visual equipment etc [1].

Several technologies have been considered in literature for implementation of home automation systems These includes : Power-line Carrier System, land line Telephone system (analog telephone service), infrared light, Bluetooth technology, Short Message Service(SMS),Web method and voice controlled system for implementation ([2], [3], [4], [5], [6], [7].

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Whichever technology adopted, Users prefer ubiquitous access to home devices instead of been uncomfortably forced to go physically to the nearest control points. Voice control automation technologies which is a trending issue has a better advantages in this regard over others technologies in terms of flexibility, easy access to the device and security.

In this paper, a prototype model of a voice based micro controller system for a home automation system is presented for controlling electrical or electronic appliances. The design transmits voice command through user wireless microphone (attached to the user cloth) to the intelligence micro controller via graphical user interphase (GUI). This provides a comfortable, efficient and cost effective model for all categories of users such as abled, disabled and elderly people in a home to control electrical and electronic gadgets such as fans, lights,etc.[7], [8].

2 Literature Review

[2] presents a smart home wireless remote control device that permits elderly people with physical challenges, in particular, handicapped and disabled people, to command their desired devices without moving around to the nearest control point. The technology uses XBee communication transceivers that receives wireless command signals and activates appliances by triggering the associated electronic relays to achieve the ON/OFF functionality. Also [9] proposed a home appliance control system that uses Infrared ray and power line communication to control the home appliances system. This system helps user to checks the status of appliances and controls them remotely from everywhere through their cellular phone or Internet.

[10] present SMS based wireless home appliance control system (HACS) for automating appliances and security. The proposed a system for controlling home appliances remotely that is useful for the people who are not at home mostly. The system provides security and controls the home appliances such as AC, lights and alarms. The system is implemented by SMS technology to transfer data from sender to receiver over GSM network. One or more computers can be used to control the home appliances. System send an alert SMS to authorized user when any intrusion is detected and user can in turn respond in order to overcome the situation. Moreover user can send SMS to system to get the status of home appliances and controlling them.

The design of voices/speech-based applications is dominated by the underlying Asynchronous Speech Recognition (ASR) technology. From a technological perspective, two broad types of ASR exist according to [11] which are Direct Voice Input (DVI) and Large Vocabulary Continuous Speech Recognition (LVCSR). DVI devices are primarily aimed at voice command-and-control, typically configured for small to medium sized vocabularies (up to several thousand words). It usually required responding immediately to a voice command employs word or phrasing spotting techniques.

[12] proposed a home automation system based on voice recognition. The system implements Automatic Speech Recognition using speech processor and MATLAB coding .The prototype developed can control electrical devices in a home or office. [13] proposed speech recognized automation system using speaker identification through wireless communication. The prototype developed can control electrical devices in a home or office wirelessly. The system implements ASR (Automatic Speech Recognition) using speech processor and speaker identification through MATLAB coding and MFCC algorithm.

[14] proposed a voice controlled wireless smart home system for elderly and disabled people. The proposed system has two main components namely voice recognition system, and Zig Bee wireless system. Lab View software was used to implement the voice recognition system. Based on the received data at the wireless receiver associated with the appliances desired switching operations are performed.

[15] proposed a model for the physically challenged and elderly people . The study demonstrates a system that can be integrated as a single portable unit and allows one to widely control light, fans, air conditioners, television sets, security cameras, electronic doors etc. The system is controlled from a microphone, FLEX sensor and PIC. The chip sends the voice command in binary sequence to the microcontroller. The base station unit takes the decision and sends the commands to the remote station by Zigbee transceiver. The sensor unit is capable of detecting when the user enters or leaves the room by measuring the change in signal strength between the access points and can accordingly turn on/off appliances such as lights and fans and in the meantime send its status back to the base station. XBee transceivers are used to eliminate the need for large amount of wiring between the processor and the appliances

While most of the literature discussed above use Zigbee transceiver and other technologies that are very expensive technology to model and implement, The design model presented in this paper uses cheaper and reliable technology - Arduino Uno IDE Micro Controller to control home appliances .

3 System Design

The design consideration in this paper is modeling a voice automation system that allows user to be anywhere in a building and remotely control electrical and electronic gadgets. The system conceptual design is presented in figure 1 consisting of four major modules; the Sensor (wireless microphone), Speech Recognising Synthesizer (SRS)/Graphical User Interphase (GUI) (in a laptop/desktop), Arduino Uno micro controller.

Wireless microphone (as sensor) captures the user's voice command. This command is transmitted to the Arduino Uno microcontroller via the GUI software developed. The users (abled, disabled and elderly people) give command through the wireless microphone connected to the PC (wirelessly), the GUI Software developed listens for audio command and transmits its processed output to the Arduino Uno micro controller. The GUI software program serves more or less as a filter since it recognizes only speech that is found in the grammar library.

A special library header (using system synthesizer) is used for this technology using C# programming language codes. A laptop or desktop connected via COM4 to an Arduino serves as the controller of the system.

The Arduino Uno micro controller was connected and powered through a 5V power supply via a USB cable from the computer. The micro controller has pins on it and a light indicator that shows when it is been powered ON. Each pin outputs 5V power supply to a bread board via a jumper wire. Another jumper wire takes out 5v from the bread board to a relay switch connected to a Vero board. Two relay switches are used to switch light bulb and Fan to ON and OFF states. The command from the user is sent to the Arduino Uno Micro Controller via COM 4, the light comes on/off.

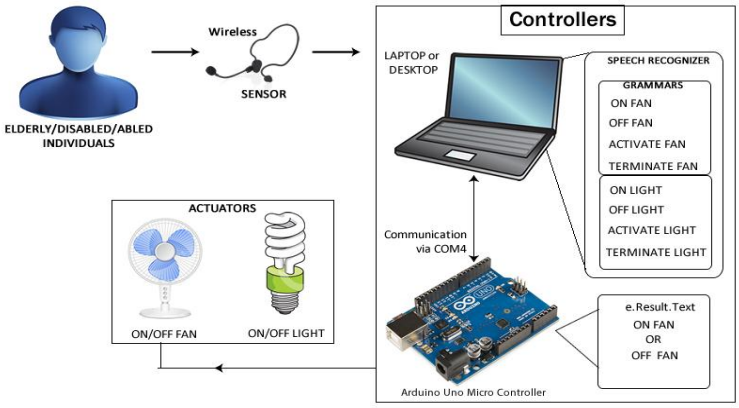

Figure 1: Conceptual Model for Voice Control System

This research work switches a light bulb or fan ON and OFF so eight (8) pre-defined grammars are used, which are.

a) Switch ON light.
b) Switch OFF light.
c) Activate light.
d) Deactivate light.
e) Switch ON fan.
f) Switch OFF fan.
g) Activate fan.
h) Deactivate fan.

As voice signal is transmitted from the microphone to the PC, the system synthesizer deciphers and puts into appropriate tokens whatever has been detected and forwards it to the Arduino, a match between this and the library pre-programmed into the Arduino gives a positive for whatever command the user desires. In this case either to ON/OFF/ ACTIVATE/TERMINATE a light bulb, ON/OFF/ ACTIVATE/TERMINATE a fan.

4 Implementation

For the implementation, four modules were developed – Control software module, Micro controller firmware programmable system module, Connectivity module (using jumper wires) and relay module to power AC/DC electric fan. The control software programmable module was written using C# programming language which is deployable on any computer running Microsoft Windows operating system. The control software communicates with the micro controller through COM4 and serial port 1.

The Graphical User Interface (GUI) was developed using Microsoft Visual Studio.Net. The code was written in a code editor frame. Since the Arduino micro controller is a serial communication device, therefore the GUI voice control / activation system application must communicate with the Arduino board via a serial communication channel. The physical connection to the Arduino micro controller is a USB cable, hence 'COM' serial communication channel was used. From the Arduino IDE, COM4 was selected,

therefore all message passed/transported to the Arduino Uno micro controller must pass through COM4 communication pathway via USB cable.

The control module encompasses a grammar library that holds the acceptable commands from the users. Also, the Microsoft speech recognition engine or speech synthesizer engine is used in the application to enable the control software application decipher the speech spoken. When a voice command is spoken, the software matches it with what is in the grammar library. If a match is found, it then uses an 'if' control structure to act on the necessary command for the micro-controller to respond appropriately.

The circuit diagram is shown in figure 2 below. In the diagram, four outputs are sent from the control software to the micro-controller, 1, or 0 for the Bulb while 'A' or 'a', are for the fan. The micro-controller is programmed to accept all four inputs through COM4 and serial port 1 under the setup control structure of the program, it then sends out a voltage signal which is 5V via pin 6 or pin 1. A jumper wire was used to send the 5V from the micro controller to the bread board. Also, from the from the bread board, another jumper wire was used to send the 5V to a pin called 'IN' on the relay module. The relay module has three pins which are 'IN', 'GND', &'VCC', the 5V goes to the IN on the relay

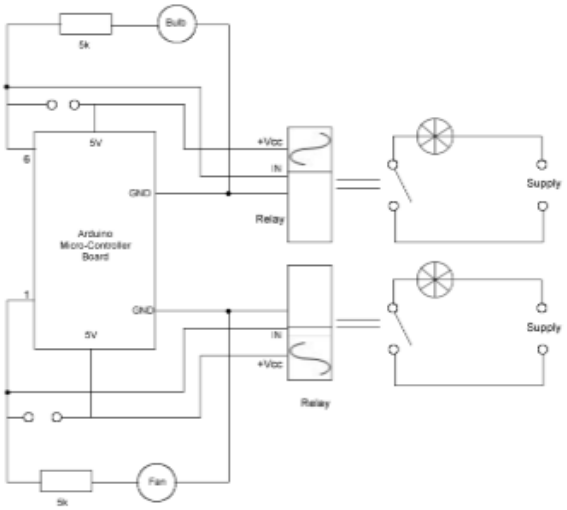

Figure 2: Circuit Diagram of the Voice Controlled Prototype Model

module, and the VCC is connected via jumper wire to the VCC on the micro controller, and the GND is connected to the GND on the micro controller. The relay module also has three holes that accept connection from an AC/DC load which are NO, COM and NC. The live wire which is the electrical wire is connected to the COM and NO for a circuit to be created. When the key closes inside the relay module due to the voice command spoken and interpretation by the micro controller, a complete circuit is created and the electric fan or light goes to ON state. Figure 3 shows a picture of the implementation setup of the Arduino Uno and the breadboard connected with jumpers.

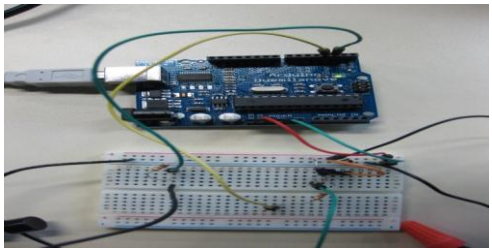

Figure 3: Arduino Uno Micro controller connected to Bread Board

4.1 Switching on the light or fan

When the serial Port method is called and an argument is passed onto it like serial Port (“1”), this tells the Arduino Uno micro controller via COM4 that is should supply 5V power supply to pin6. Then pin6 supplies the bread board through looping of a jumper wire from the pin6 on the micro controller to the Vero board. A relay switch is connected / mounted on the Vero board. This 5v coming from the Vero board triggers an electromagnetic field inside the relay switch to close the switch for a complete circuit to take place. When the complete circuit takes place, the light bulb goes ON. The same principle applies for turning on the fan however, to turn on the fan the argument to the serial port is ("A"). The micro program code snippet (written in C language) for Arduino Uno Controller for switching the bulb on and off is shown in figure 4 below .

```
int message = 0; //this holds one byte of the serial message

intBULBPin = 6; //this is the pin that the jumper wire is connected to
intBULB = 0 //the value or brightness of the LED (off state 0v).
void setup(){
Serial.bigin(9600); //set serial to 9600 baud rate
If(serial.available()>0) //check to see if there is a message
{
Message = Serial.read(); // Put the serial input into the message
If (message == ‘1’){ //If capital A is received
BULB = 255; //set BULB to 255 (ON) state of 5v
Serial.println(“BULB ON”); //send back BULB ON}
if(message == ‘0’){ // if lowercase a is received
BULB = 0; // set BULB to OFF state of 0v
Serial.println(“BULB OFF”); //Send back BULB OFF
// end of code snippet}}}
```

Figure 4: C language code snippet for the Arduino Uno Microcontroller software to light the bulb

To activate the system for speech / voice authentication to take place, Jarvis plus the command syntax in the grammar library i.e. Jarvis + ON fan. Conversely Jarvis + OFF deactivates the system.

4.2 Switching off the light or fan

When the serial Port method is called and an argument is passed onto it like serial Port (“0”) or serial Port("a"), this tells the Arduino Uno micro controller via COM4 that is should supply 0v power supply to pin6 or pin1. Then pin1 supplies the bread board through looping of a jumper wire from the pin1 on the micro controller to the Vero board. The light bulb is connected to the Vero board as an indicator that 0v supply is in action. A relay switch is connected / mounted on the Vero board. Since a relay needs a little

supply of 5V to trigger the switch inside to complete the circuit and cannot be found in 0v then the switch key opens and an incomplete circuit is created and the fan or the light is OFF.

5 Conclusion

This paper has presented a model of a voice based controlled system for home appliances. This has effortlessly, solved the problem of movement for all categories of people such as elderly, disabled or even abled people in an attempt to control home appliances. Though this work is limited to home appliances with maximum of five volt (5V), further works can accomodate home appliances with above five volts (5V+). Also, we intend to integrate variable control functions to improve the system versatility such as providing control commands other than ON/OFF commands. For example "Increase Temperature", "Dim Lights" etc. Another area to consider is controlling of home devices via web and mobile platform.

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