

A VOICE CONTROLLED **SMART HOME** **AUTOMATION SYSTEM**

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Abstract:

This paper proposes an automation system where users can use voice commands to control basic home appliances. Home automation system design is a reliable solution for those who need a special attention such as elderly person, sick patients, and handicapped person. This paper discuss the voice control Smart Home System that allow people control their home devices by voice command [1].The proposed system needs to be trained of voice commands only once. Then the system can recognise the voice commands independent of vocabulary, noise and speaker characteristics (i.e. accent) and further control the home appliances [2]. It is cost effective but yet flexible, robust, adaptable and secure Home automation system [3].

Keywords:

Smart Home automation, Voice command, Voice Recognition, Voice Recognition Module V3

Introduction:

Smart Home:

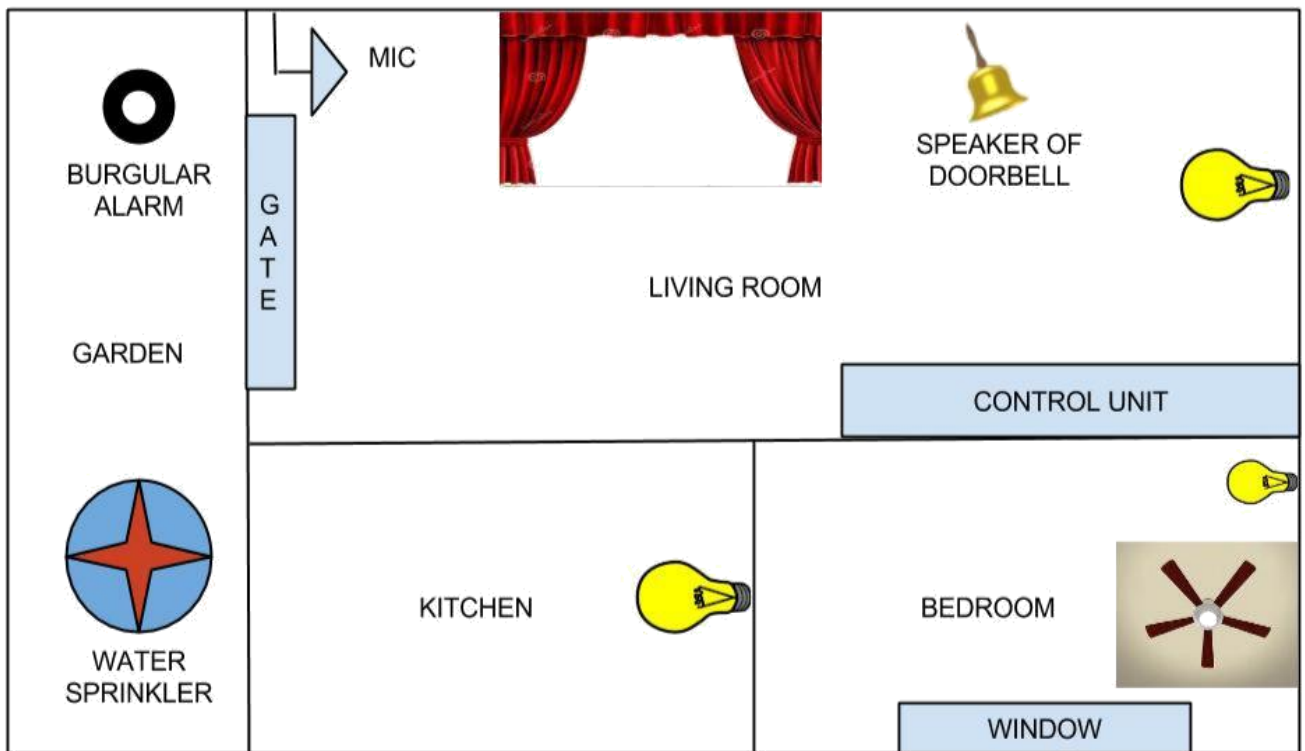
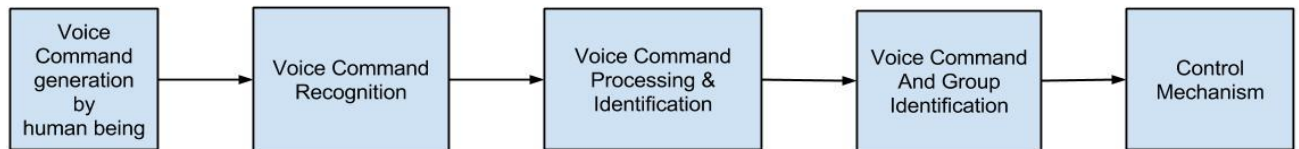
A smart home is a space or a room which is provided with the ability to get accustomed by itself to certain situations to make the occupants feel comfortable. Smart homes could be simple remote control of electrical appliances or more complex functionalities such as monitoring of the house interiors using speech recognition. Sensing, anticipating and accordingly responding to the various activities in homes is the basic requirement of such systems [4].

Home Automation and Technologies:

Home automation is a very promising area. Its main benefits range from increased comfort and greater safety and security, to a more rational use of energy and other resources, allowing for significant savings. A typical wireless home automation system allows one to control and monitor house hold appliances from a centralized control unit without physical movement and labor. This application domain is very important and will steadily increase in the future [5].

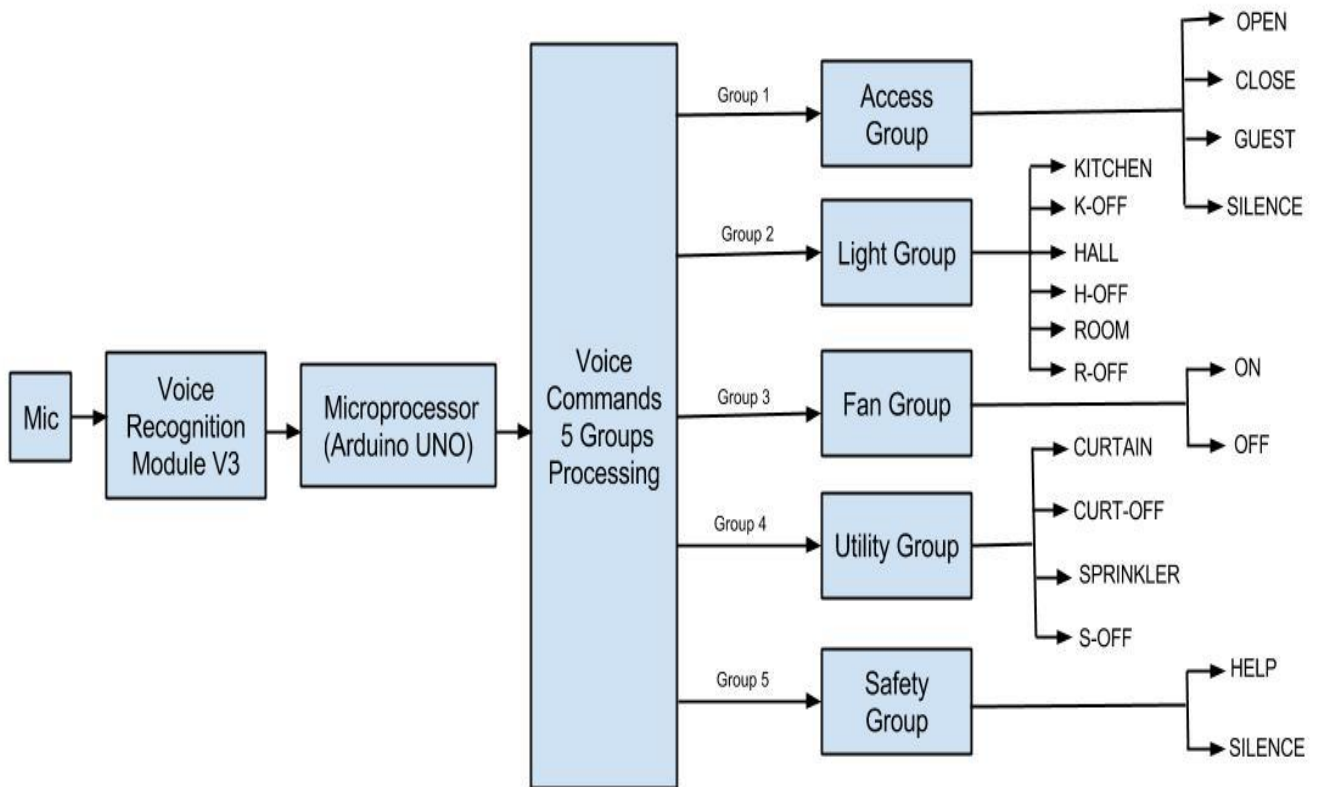
Voice operated command and home appliances:

The home automation system comes with the ability to control home appliances like fan, light, drapes, electronic door, security alarm, water sprinkler, etc. using different voice commands. This is a demonstration of how to design and build a multi-purpose wireless system that can switch OFF and ON any electrical household appliance depending on the voice produced by the user [6].



Work in this paper:

The speech commands are loaded and recognised by Voice Recognition Module V3 and implemented on different appliances using micro-controller (Arduino-UNO). Experiments were conducted with different speakers (male/female voice) while varying the distance between mic and mouth. Different commands were prompted and responses are analysed on the above parameters.



Overall working of Smart Home Automation

Organisation in this paper:

This present paper is organized as follows. In Section II we will discuss smart home function including overview of Voice Recognition Module V3. Section III provides an overview of Home Automation which include software and hardware implementation.

Project experiments and results are presented at Section IV, while the conclusions are given in Section V.

Section II

Smart Home Functions

The proposed method is aimed at designing a voice controlled smart home control system for the following reasons. One of the major problems in our present day society is wastage of energy, whereby energy consumption is continuously increasing year by year.

Nowadays, some people may be too lazy or too busy to get up and turn off a particular appliance. Hence, the smart home control system will be useful as one will only have to speak to turn off a device, thereby saving energy as well as one's time. Moreover, old or disabled persons may experience difficulties in going around the house to turn on/off their appliances, especially if they live alone. It will be much easier for them to use the voice control system. It will also help blind people as they will be able to turn on a fan or a radio without relying on others. The system is designed in such a way that it is easy to install and use [7].

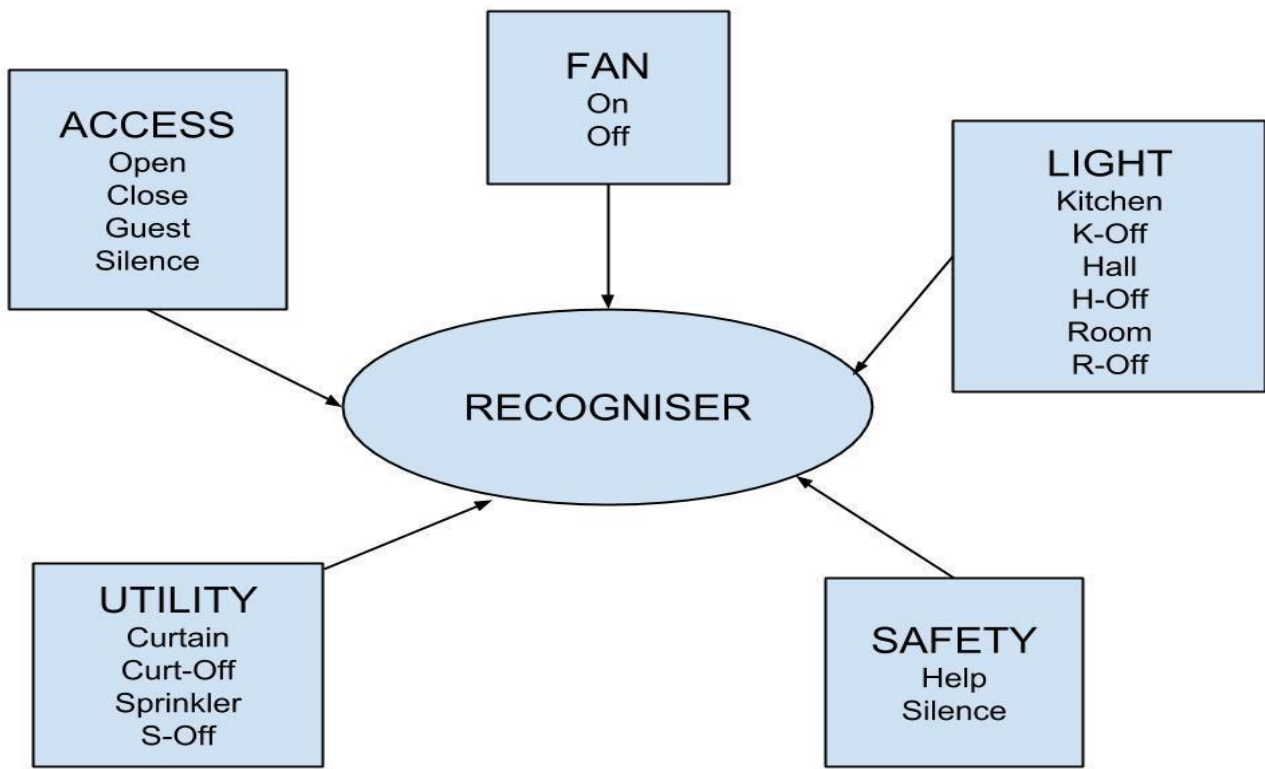
Voice Recognition Module:

The proposed method uses a Voice Recognition Module V3 for speech processing and recognition [8].

It support maximum 80 voice commands each of 1500ms and maximum 7 voice commands are effective at the same time. In this module the VoiceRecognitionV3 library of Arduino is used [9]. There are two steps to load a command:

1. Train -- the process of recording your voice commands using microphone, stored in flash (number from 0 to 79).
2. Load -- copy trained voice to recognizer.

Recognizer is a container where acting voice commands (max 7) are loaded. It is core part of voice recognition module. Group helps to manage records, each group have maximum 7 records.



Grouping the commands in VR module.

Section III

The system can be divided into 3 main parts:

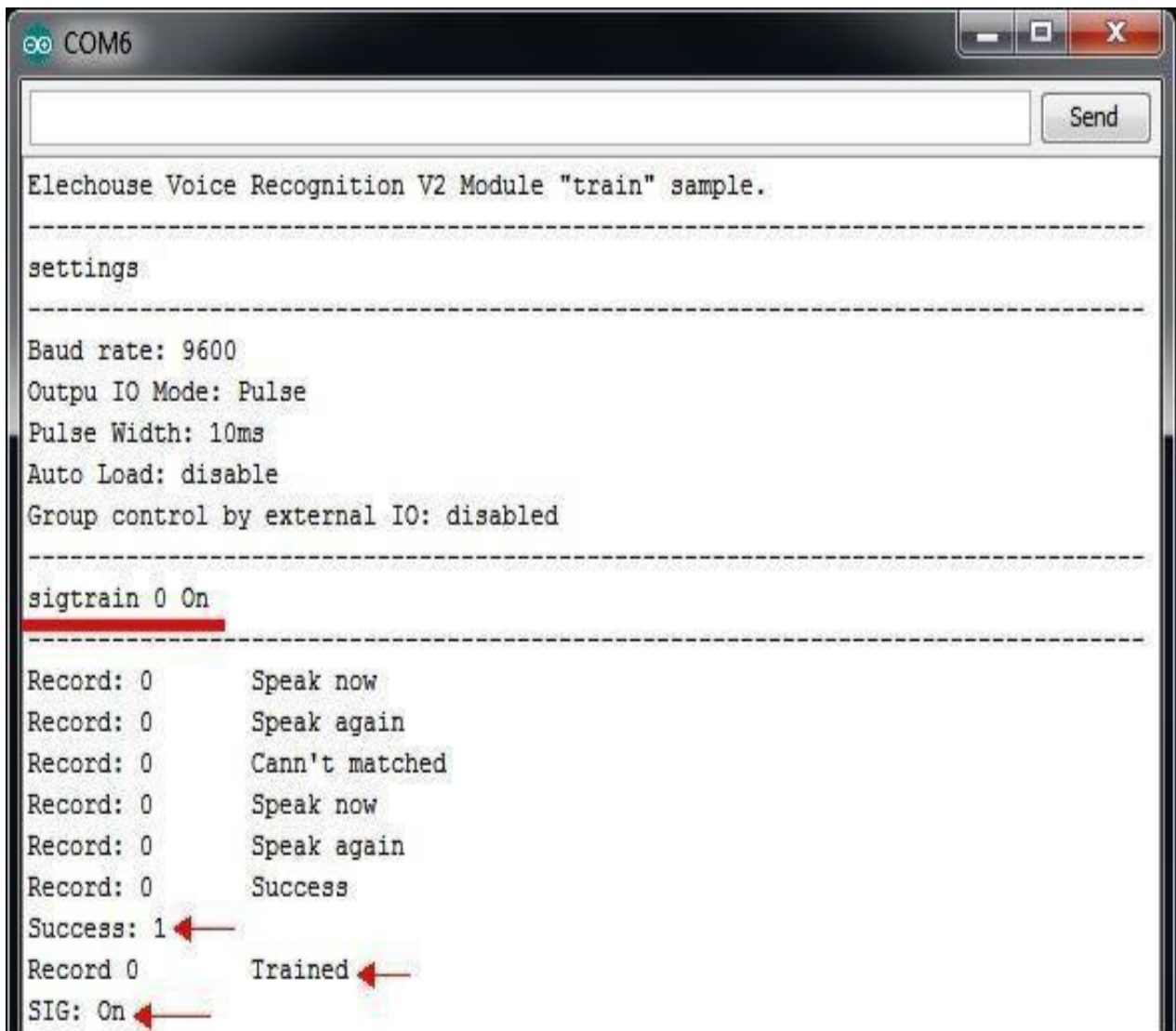
1. **Voice recognition part** -> Microphone and Voice recognition module V3
2. **Transmission part** → Transmission of input command between module and Arduino UNO
3. **Control Circuit part** → Arduino UNO controlling various appliances at home.

Software Implementation

In **the voice recognition part** of the system the voice is captured by the microphone and given to the Voice Recognition Module V3. To train a command we have to follow these steps:

1. Choose right Arduino board (Tool -> Board, UNO recommended), Choose right serial port.
2. Upload vr_sample_train. (File -> Examples -> VoiceRecognitionV3 -> vr_sample_train).
3. Open Serial Monitor. Set baud rate 115200, set send with Newline or Both NL & CR.
4. In order to train record 0 with signature "On", send "sigtrain 0 On" command.

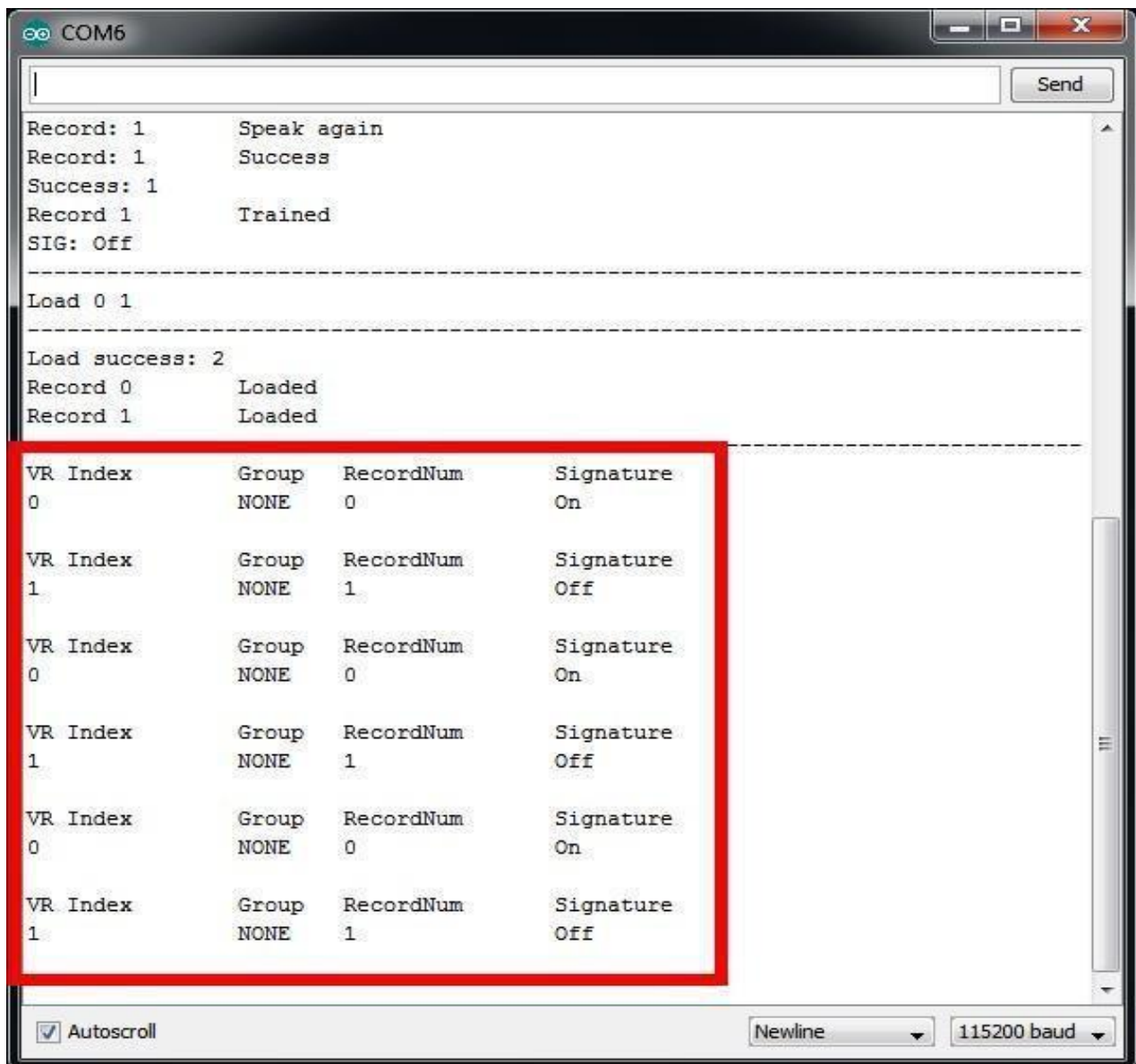
When Serial Monitor prints "Speak now", you need to speak your voice and when Serial Monitor prints "Speak again", speak it again. If these two voice are matched, Serial Monitor prints "Success", and "record 0" is trained, or if are not matched, repeat speaking until success.



Training the voice commands

When training, the two led on the Voice Recognition Module can indicate your training process. After sending the training command, the SYS_LED (yellow) is blinking fast which remind you to get ready. Speak your voice command as soon as the STATUS_LED (red) light lights on. The recording process ends once when the STATUS_LED (red) lights off. Then the SYS_LED is blinking again, get ready for next recording process. When the training process ends successful, SYS_LED and STATUS_LED blink together. If the training fails, SYS_LED and STATUS_LED blink together, but quickly.

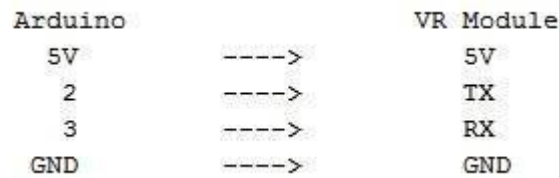
5. Send "load 0 1" command to load voice in recognizer and speak the command in microphone to check whether your voice is recognised or not. If recognised, then VR Index, Group, Record Number and Signature details are shown.



Loading and Recognition of trained voice commands

Hardware Implementation

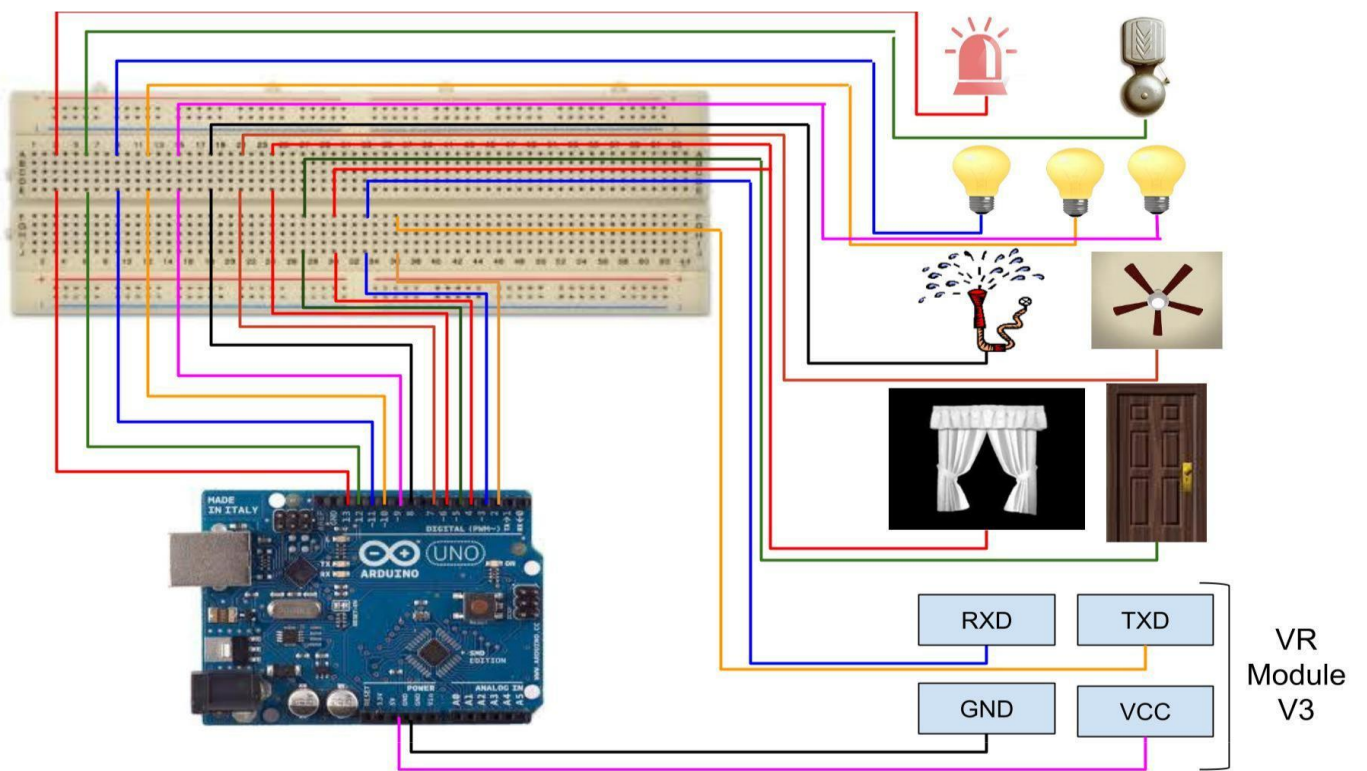
The **transmission part** of the system deals with transmission of signals. Once voice commands have been recognized, corresponding control characters are sent to the microcontroller (Arduino) through the transmitter at a baud rate of 115200 bps [10]. Arduino and VR Module is connected-



In the **control circuit part**, the transmitted control characters are received by the microcontroller and compared with already loaded voice commands. If there is a match, the microcontroller will turn on/off the corresponding appliance connected to it [11].

In this paper we discussed 4 types of controls in Smart Home Automation :

1. **Access control** monitors the opening and closing of electronic door and door bell. It ensures the security of the house by allowing authorised person to enter. Electronic door system can be installed in garage and other private premises.
2. The **On/Off control** monitors the turning on and off the lights and fan of different rooms. The brightness of light can also be regulated which, in turn saves energy.
3. **Safety control** monitors the burglar alarm.
4. **Utility control** monitors the water sprinkler, curtains.

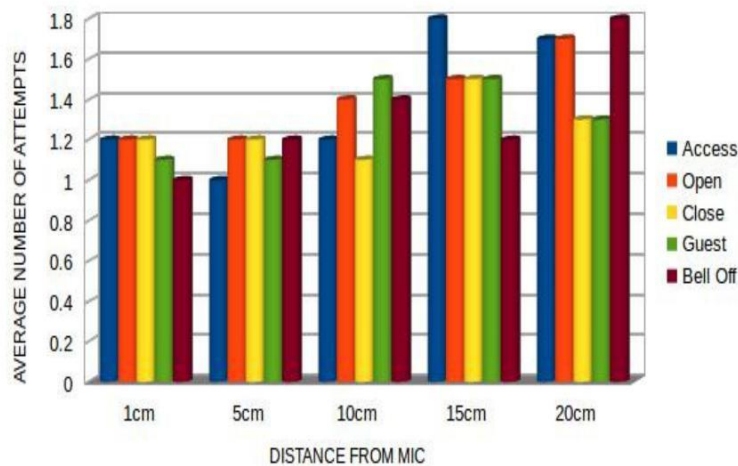


Connection between Arduino (UNO) and different home appliances

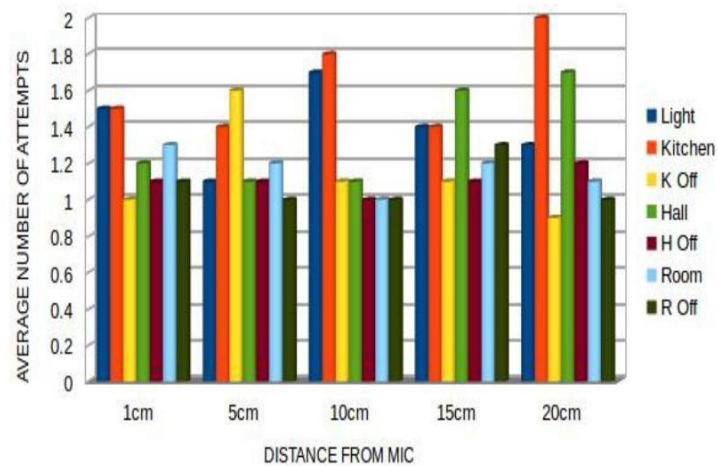
EXPERIMENTS

Experiment was conducted with various people prompting all the commands at different distances. Records of 10 speakers (5 - male, 5 – female) aging between 19 to 20 years were taken at distances ranging from 1cm to 20cm of all the commands. In the graphs shown below, the Y- Axis is the average number of attempts and X - Axis is the distance of mic from the speaker in cm.

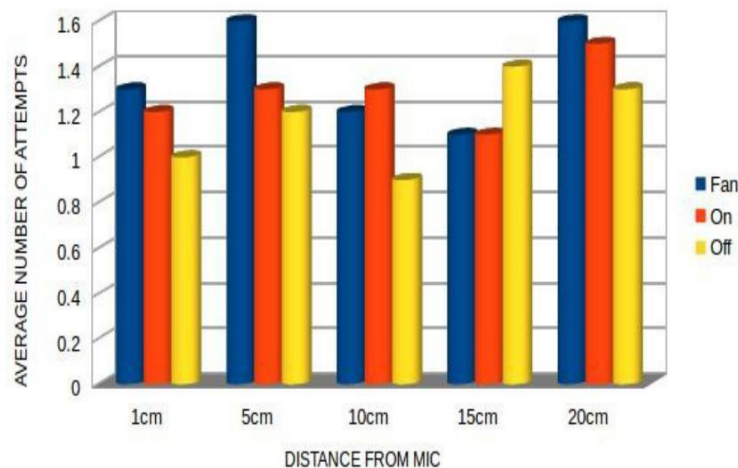
ACCESS GROUP



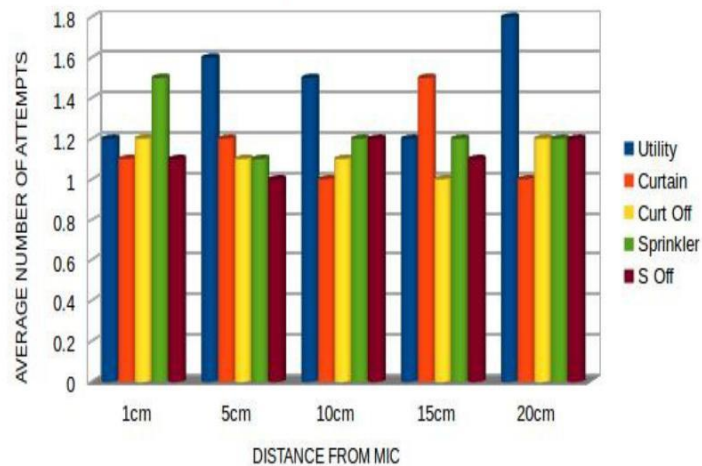
LIGHT GROUP



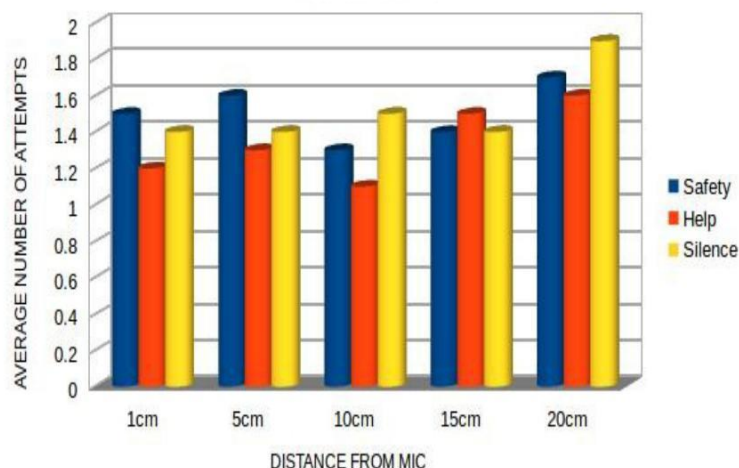
FAN GROUP



UTILITY GROUP



SAFETY GROUP



RESULTS

SAFETY GROUP:

1. Safety: No definite pattern.
2. Help, Silence: number of attempts increases with increase in distance.
3. Best Distances:

S.No	Command	Best Distance (cm)	Number of attempts (average)
1	Safety	10	1.25
2	Help	10	1
3	Silence	1	1.3

2. UTILITY GROUP:

1. Utility, Curt Off, Sprinkler, S off: No definite pattern.
2. Curtain : Number of attempts increases with increase in distance.
3. Best Distances and Average Number of attempts:

S.No	Command	Best Distance(cm)	Number of Attempts (average)
1	Utility	1,15	1.2
2	Curtain	10	1
3	Curt Off	5,10	1.1
4	Sprinkler	5	1.1
5	S Off	5	1

3. LIGHT GROUP:

1. Light, Kitchen, K Off, Hall, H Off, Room, R Off: No definite pattern.
2. Best Distances and Average Number of attempts:

S.No	Command	Best Distance (cm)	Number of Attempts (average)
1	Light	5	1.1
2	Kitchen	5, 15	1.4

3	K Off	1	1
4	Hall	5,10	1.1
5	H Off	10	1
6	Room	10	1
7	R Off	5,10	1

4. FAN GROUP:

1. Fan, Off : No definite pattern.
2. On : Number of attempts increases with increase in distance.
3. Best Distances and Average Number of attempts:

S.No	Command	Best Distance (cm)	Number of Attempts (average)
1	Fan	15	1.1
2	On	15	1.1
3	Off	5	1.2

5. ACCESS GROUP:

1. Open, Close : No definite pattern.
2. Access, Guest, Silence : Number of attempts increases with increase in distance.
3. Best Distances and Average Number of attempts:

S.No	Command	Best Distance (cm)	Number of Attempts (average)
1	Access	5	1
2	Open	5	1.2
3	Close	10	1
4	Guest	5	1
5	Silence	1	1

CONCLUSIONS

The proposed system in this paper is largely focused on implementing voice recognition in existing as well as new residential spaces. While voice recognition is a great technology to make peoples life easier, there are certain other techniques which can help improve the living experience of the person even further. Developing a mobile application for the same would aid in providing access to the voice recognition module from outside the home. This would enable users to control their appliances from remote location. A good use case of this would be an owner switching on the geyser through voice command on the mobile application while coming back from the office or asking the television to download the next episode of a sitcom from outside home.

In the graphs, lower the height of vertical bars i.e, less number of attempts required to recognize the command and thus make VR Module more feasible to use.

1. Average number of attempts required to recognise a command in Voice Recognition Module V3 is 1.102.
2. The VR Module will give the best result in the range 5cm to 10 cm.
3. The VR module will give best result at 7.25cm.
4. The following table shows the comparison of best distance between speaker and mic calculated using mean and standard deviation.
5. Arduino UNO will work as independent unit, its an open source software.
6. In VR Module, we have to train voice commands only once and it can implement multiple functions at the same time.

S.NO	GROUP NO	BEST DISTANCE CACULATED BY MEAN	BEST DISTANCE CALCULATED BY SD	AVERAGE NO OF ATTEMPTS
1	ACCESS	5	5	1.06
2	LIGHT	7.5	10	1.1
3	FAN	15	15	1.087
4	UTILITY	7	5	1.06
5	SAFETY	10	15	1.125

APPENDIX

Code Details-

- Commands- ACCESS, LIGHT, FAN, UTILITY, SAFETY loaded.
- Group Command Index recognised.
Control Commands of group loaded.
- Control Command Index Recognised.
Commands are compiled.
- Group Command Index recognised.
Commands- ACCESS, LIGHT, FAN, UTILITY, SAFETY loaded.
Eg- Hall lights on and Sprinkler off
 - Record - ACCESS(25), LIGHT(26), FAN(27), UTILITY(28), SAFETY(30) loaded
 - Command Index Recognised- 26 (LIGHT group Loaded)
Record - Kitchen (7), K off (8), Hall (9), H off (10), Room (11), R off (12) loaded
 - Command Index Recognised -9 (Hall)
Led at pin 10 – HIGH
 - Command Index Recognised-26 (LIGHT group exit)
Record – ACCESS (25), LIGHT (26), FAN (27), UTILITY (28), SAFETY (30) loaded
 - Command Index Recognised- 28 (UTILITY group Loaded)
Record – Curtain (19), Curt off (20), Sprinkler (21), S off (22) loaded
 - Command Index Recognised -22 (S off)
DC motor at pin 7 – LOW
 - Command Index Recognised-28 (UTILITY group exit)
Record – ACCESS (25), LIGHT (26), FAN (27), UTILITY (28), SAFETY (30) loaded

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