A Review on Home Automation Using Voice Recognition

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Abstract – Home automation is the concept of making any home “smart”. A smart home is a network of interconnected devices which can be controlled by the user, in the most convenient way possible. This paper reviews various ways in which people can automate their homes. An ideal home automation system must provide a balance between cost, robustness, reaction time, processing power, flexibility, security and convenience among others. This review paper elaborates the different methods of integrating voice recognition technology in home automation systems.

Key Words: Home Automation, Voice Recognition, Wireless Technology, Cost, Arduino, Artificial Intelligence, Bluetooth.

1. INTRODUCTION

Home automation has recently come into the limelight and thus has undergone large scale development. Everything from lights and gas stoves to a garage door can be controlled using a central panel in the house or through wireless devices using an application or even voice commands. It has been a huge advancement in technology, where it proves very useful in big houses or for the differently abled such as for the blind etc.

It goes from basic switch controls that turn the lights on/off to creating different environments in the house based on requirements or mood, calling an Uber cab for you, controlling the HVAC systems of the house, Audio Visual entertainment systems etc. and many other advanced functions in the technological aspect.

Home automation is not only a luxury, but for certain demographics like the quadriplegic, the elderly and the differently abled, it can be of great assistance. A home automation system makes them independent and self-reliant to a certain extent.

The current market leaders in home automation technologies are Google Home, Amazon Echo, Alexa, Wink Hub, Logitech Harmony and Apple HomeKit. All of these are only the control hubs and require the purchase of home automation compliant appliances to function. Examples of such appliances are Phillips Hue, Nest Thermostat, Canary, Sthenri, Google Cast and Avion.

The papers we studied did not rely on such devices. Instead they built their own test network of devices using cost effective components like micro-controllers and relay circuits on which they ran their respective algorithms.

2. LITERATURE REVIEW

Mohamed S. Musbah et al. adopts a client/server model and is designed to control home appliances using voice recognition technology. The model consists of three main components

i) Front End User Device: Can be any mobile device such as a laptop or smartphone with a good microphone and voice recognition feature. The device used in this paper is a Windows 7 PC which contains an inbuilt Windows 7 Speech Recognition Software.

ii) Home Server: Can be any laptop or a computer which consists of a Wi-Fi adapter and a Windows operating system (Windows XP or higher).

iii) End User Device: Consists of two parts, Arduino Uno to process the incoming commands and the home devices.

The devices considered in this paper are a D.C. fan and LED lights. The front-end device primarily contains two voice commands namely start listening and on/off. The device application establishes a connection to the home server via a wireless ad-hoc connection (TCP/IP transmission protocol). The home server in turn acknowledges the connection and receives commands from the front end interface while opening a connection to the microcontroller and then forwards the command to it. Now the Arduino uno implements the given command according to the target device. The working is illustrated in the fig [1].

![Fig-1: Working Model](image-url)
Sushant Kumar et al. approaches home automation through voice recognition and user interface control. Both functions are carried out using a smartphone. The interfaces interact with each other using efficient Bluetooth wireless communication.

End user control consists of a combination of google voice API and the AMR voice app which understands the voice commands. The Arduino Bluetooth control serves as the touch based application with support for up to 8 devices.

i) **AMR Voice:**
   a) Connect Bluetooth through the app.
   b) Tap the mic icon and command.
   c) HC05 receives the command and forwards it to the Arduino.
   d) Arduino implements the task through relay switches.

ii) **Arduino Control Application:**
   a) Connect Bluetooth through the app.
   b) Tap ON/OFF for specific appliance.
   c) The app communicates the specific command to the HC05. Arduino processes and executes the command.

The key steps of this implementation are:

a) Voice Recognition using a dedicated module and a microphone.

b) Command Interpretation using a voice recognition module and a microcontroller working in unison.

c) Sending control signals to devices depending on commands.

The Access group is used to open or close doors and uses NFC. The Light and Fan group are used to control the lights and fans throughout the house. The Utility group controls the sprinklers and blinds. The Safety group is used to sound an alarm and silence it.

Yash Mittal et al. talks about developing a home automation system using a dedicated hardware module for the voice recognition module and a Arduino Uno microcontroller to send respective commands to devices. The voice commands are divided into five groups with up to seven commands in each group. The command groups are Access, Safety, Fan, Light and Utility. The user has to state the group name followed by the command for it to register successfully.

The voice recognition module is trained using the voices of five male and five female users. This ensures that the system can recognize voice commands irrespective of user age, gender, accent and distance from microphone.

A bar graph of the average number of attempts it takes to successfully recognize a command at different distances from the microphone is generated to determine the best position for placing the central microphone.

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Home automation is a new and relatively broad concept which encompasses a wide array of different technologies. To compare how different ways of implementing a single module fare against each other, we need to have well-defined performance metrics and a way to measure the same. The performance metrics we have chosen for this assessment are:

1. Flexibility: A home automation system needs to adapt to different users and their requirements. It needs to be able to recognize voice commands from all users irrespective of their age, gender, accent and pitch. It must also be able to work with appliances the user already owns, so that he doesn’t have to purchase additional appliances. The system must have multiple interfaces so that the user can choose whichever is most convenient to him. Interfaces can include a simple voice command interface, a mobile application to control devices or a central hub with all these options.

2. Robustness: A home automation system needs to be robust i.e. it should work even under less than ideal conditions. The voice recognition module must be able to recognize commands even when the user is at a distance from the microphone [6]. Ambient noise and background disturbances must have minimal impact on performance. Suppose the microphone is placed in a room where both, a noisy fan and a television are turned on and the user wishes to give a command. It wouldn’t be viable to expect the user to mute the television every time he wants to give a command, therefore a good home automation system must take all these factors into consideration and find a way around them.

3. Security: Modern home automation are also used to lock and unlock the doors in a house. It is obvious that if the system is wired, the cost of labour that is needed for installation needs to be kept in mind. Interfaces can include a simple voice command interface, a mobile application to control devices or a central hub with all these options.

4. Cost: A major factor that decides how successful a home automation system is the cost the user has to incur. A system may have all the latest bells and whistles, but if the user cannot afford it he simply will not buy it. Cost includes but the initial cost of the product as well as the cost of installation and long term maintenance. An automation hub may appear to be cheap but when you consider the cost of all the additional appliances you need to buy along with the hub, the cost adds up. Also, if the system is wired, the cost of labour that is needed for installation needs to be kept in mind.
5. Response Time: Everyone today is used to instantaneous results, therefore in order for a home automation system to be truly useful it must respond to inputs in the shortest time possible. Some algorithms give superior results for command recognition but the time they take for computation is not ideal. An ideal algorithm would be one which strikes a perfect balance between computational power and response time.

4. OBSERVATIONS & ANALYSIS

Table-1: Observations of various methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Flexibility</th>
<th>Robustness</th>
<th>Security</th>
<th>Cost</th>
<th>Response time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The System is trained according to the user therefore it is flexible. This method is highly adaptable to any environment because of low requirements</td>
<td>The Accuracy with a Dedicated microphone is 60% - noisy and 80% - quiet Accuracy without using a dedicated microphone is 30% - noisy and 60% - quite</td>
<td>No security issue is Addressed.</td>
<td>Since we are using just 2 PCs and Arduino UNO the cost is minimal</td>
<td>The time taken to execute a command for a distance between 10-15 meters is 145 milliseconds</td>
</tr>
<tr>
<td>2</td>
<td>The system is flexible as it uses open source applications from the android play store thus adding to the Database while learning Commands and referring To files from All over the world.</td>
<td>Robustness depends on OS company of the mobile and quality. Even after that the system performance is 87% accurate. Noisy environment mildly affects the system.</td>
<td>Secure protocols are used over the internet As it uses google apis.</td>
<td>The need of mobile devices of the user drastically reduces the Hardware cost and only requires basic modules to Make the environment smart. Thus, less costly.</td>
<td>With a Bluetooth range of up to 20 meters, the system performs within 1 to 3 seconds with a good internet connection and maximum 5 seconds with slow internet. Response time is above average.</td>
</tr>
<tr>
<td>3</td>
<td>Flexible since voice Recognition module is trained for various demographics. Can adapt to any environment</td>
<td>Works well even when the user is far away from the microphone. Performs well under low levels of noise but Performance decreases with higher levels.</td>
<td>Channel is secured before transmission can take place. High security.</td>
<td>Cost is minimal since a single microcontroller and voice recognition module is Used.</td>
<td>Average response time.</td>
</tr>
<tr>
<td>4</td>
<td>Flexible as speech module can be trained. Can be applied to any home except for the adjustment of bed part.</td>
<td>Accuracy in silent condition 60%. Accuracy in noisy conditions 80%.</td>
<td>Almost negligible Security</td>
<td>The home automation equipment is very cheap. Cost of wooden bed Not included</td>
<td>Average response time.</td>
</tr>
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</table>

5. CONCLUSION

In conclusion all four of the methods were cost effective as compared to the market staples like Google Home, and were implementable easily with readily available equipment at home but, the home automation sector is still in its early stages and its popularity is growing by the day. There is a lot of scope in this topic as discussed in all the four papers.

The main challenges faced were speech recognition in noisy conditions, the training of the voice recognition module, number of commands stored in the database of the voice recognition module and the response time or the latency of the module and the device on which the code was embedded. Overall, these creases can be ironed out by researching further and the system can be made quicker and more intuitive.

6. FUTURE SCOPE

With the increasing demand for convenience and entertainment, home automation is just a step away from being the most in demand technology in the near future. We can develop a wireless home automation system that will take voice commands from the user to control various appliances throughout the house. We plan to make our system adapt to the existing appliances of the house rather than buying exclusive appliances that the various existing home automation systems require. The basic objective of this project is making this technology more economical and thus more reachable to the common man. We intend to use
Raspberry Pie 3 for this project which will help in making the system wireless.

REFERENCES


