

# Touch-less Home Automation System with Voice and Gesture Control

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**Abstract**—The concept of home automation has been making rapid advancements in technology and features ever since it was introduced to the world for the first time. Automation has been serving as a wide domain for research. In the present scenario, the world is shifting towards automation, for it gives better efficiency and more features. Same is with home automation. A smart home can be termed as an automated system, which enables the user to have access over all its devices, and provides a user-friendly interface as well. For connectivity amongst devices, keeping an all-time active internet connection might not be pocket friendly for all, however, if connectivity can be ensured amongst devices without the presence of internet or any external network, it will make the system a lot more secure and cheaper, making the devices accessible to the user (for a specified range) and providing a user-friendly interface, to empower the user to connect to the device in a friendly manner. Apart from that, it will also prove to be a blessing, as it provides simple topology connection which will indeed help in easy operation and diagnosis of faults (if any). After the implementation of such ideology, it can be concluded that besides being pocket friendly to user, it can also lead to the development of revolutionary changes in the concept of automation, for same efficiency and the majority of features are being provided to the user.

**Keywords**—Smart Home, Automation, Voice and Gesture Control, Contactless

## I. INTRODUCTION

The concept of Smart homes has shown huge growth over the last few years. Apart from being energy-efficient, they empower the user to have access over every device and monitor it accordingly. For any smart-home, all the devices are to be kept interconnected, in order to give best user experience, for ensuring the same, designing an inter-device connectivity map/topology might seem to be difficult. Moreover, for ensuring all-time connectivity amongst the devices, development of a separate server or portal might also not seem pocket friendly to all. The following ideology aims at providing the same features, access and user-friendly interface to the user for a specified range and is quite cheaper and relatively easier to implement. The connection/ topology design is quite easy to make, which also gives an advantage at the time of diagnosis and correction of problems. With a

specified range, this system ensures easy accessibility which empowers users to have control over any required device within a specified range, and that even, without making any physical contact with it. The whole system is voice/ gesture operated, which makes it quite classy and user-friendly. By simply either giving voice-commands or making physical gestures in front of allocated sensors, one can easily operate any device of their choice. Apart from that, a Master-Switch has been provided to keep the working of system centralized at one single place. For in case at the time of gatherings, where due to too much noise or due to huge crowd, gesture sensitivity can be utilised to operate the system. Any unnecessary reflexes can be avoided due to the customised sensitivity and small range for gesture detection. Every party/ gathering keep running smooth. For every room, a separate Master-Switch is there which ensures proper and user-friendly experience. However, there is no restriction over existence of other client switches. For being Touchless, there is no fear of shocks/ impurities even any physically disabled person can operate any device of their own choice by simply giving voice commands

## II. LITERATURE REVIEW

The concept of automation was introduced in 1946 (mid-20th century) ever since then, the concept itself is making revolutionary changes in this industry. Basically, Automation industry is not allied to any specific domain/industry, the concept of automation mainly focuses on automating any gadget/machine to reduce the work load and proceed accordingly as per specified requirements. Most common example of automation is Smart-Home. The concept of smart home is so impressive that within a couple of years, it has acquired a huge portion of global market. According to a leading research firm, it was seen that automation market saw a CAGR of 8.8%, with a projected score of acquiring market size of 368,372.4 Million USD by 2025 (from 190,882.2 Million in 2017) [1], while talking about Home Automation, the market saw a CAGR of 12.1% (Greater than 8.6%) and the expected size by 2025 was 114 Billion USD (From 45.8 Billion USD (2017)) [2], which is comparatively greater than the growth of Automation.

Bluetooth based Automation System using Cell-Phone- [3] by using Bluetooth module and Arduino BT Controller, we can setup a wireless mode of communication in between our cell-phone and Bluetooth module which can help us to get access over the relays, to switch devices ON/OFF easily. Access to the system gets a lot easier, moreover, the setup is user-friendly, where the user gets an option to choose the point to be accessed.

For the working of this system, it proves to be even more advantageous, as no external setup of any network is required for functioning of system. The system provides additional feature of security, named Authorization, where the user needs to authorize themselves before accessing the feature. The system is portable, hence can be controlled easily by cell-phone.

Voice Recognition Based Wireless Home Automation System- [4] By using a handheld microphone for giving voice commands to operate the appliances might help physically disabled people a lot as no special involvement of hand movements is needed. Apart from that anyone can activate any connection from any point in range, however, decrease in voice intensity becomes an issue which might lead to some obstructions.

Using a handheld- microphone module, and a ZigBee RF transmitter, the following prototype has been designed, for purpose of providing a voice-assist feature for users. The system helps giving ease of access to user, and freedom of operating any device for any specified range. It is advantageous, for physically disabled users, who are unable to operate their hand/feet. Wireless configuration of circuit makes it look cleaner and simpler.

Gesture based Home Automation system- [5] The following system basically focuses on providing the accessibility for differently abled persons. Using MATLAB, different gestures are recorded for each purpose and are detected using camera (as input device) after that, using NL Harris Algorithm, each gesture is detected and concluded after proceeding along the specified steps. It empowers differently abled persons, and makes access to every device/gadget easy. Its working proceeds with background separation, normalisation, and hence, it is quite precise.

### III. OBJECTIVE(S)

Our System delivers high-end performance with maximum efficiency with the help of radio frequency communication. The main idea focuses on the concept of automation. The system has no pre-requisites, which means it is fully compatible and can work with all devices, without any additional integrated features required in appliances/ devices. For user safety and ease of access, the system ensures that no physical touch is required from the user's side for accessing the proposed features. Besides, the idea is beneficial even if it is to be accessed by any physically disabled user (using voice commands to interact with the system). The system is quite cheap as there is no required expenditure to be spent over networking or interconnectivity amongst devices. The system is meant to empower the user to have proper control over all the devices within their specified ranges. The system ensures wireless transmission of data amongst components to avoid heavy wiring and complex circuits. Any device/appliance can be controlled (within the range) from the user just by their voice commands or gestures. The system interacts with the user directly without using any application or software to

provide any interacting panel. The system has a separate master switch for centralised working and interpretation of commands. However, the client switches may be located anywhere throughout the user's space. The system ensures energy conservation and hence sensitivity is optimised so that unintentional gestures/sounds can be neglected. The gestures and voice commands are quite simple, yet attractive, so they are easy to memorise and replicate. Apart, the devices/components used for developments of this system are quite cheap and easy to find in the market. The supporting connections and topology are also very easy which makes this system quite efficient for usage and diagnosis as well.

### IV. WORKING

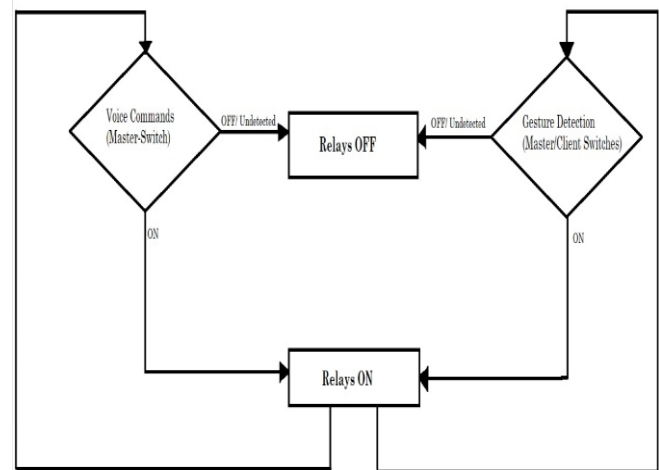


Fig. 1. Flow Chart

The complete system consists of the Master-Switch and Client Switches, which are the main components available for direct access for the user. The client switches basically are minor switches which may be present anywhere around the room. The Master Switches on the other side, are the centralised switches, which includes the modules required for voice assists. Master Switch can be termed as a primary switch as well, for the complete switching process of the room is governed by it. The main working of any designed switch (here) basically decides which relays/ switches to operate on. However, for client switches, there is an all-time wireless-connection active in between the master-switch and those client switches. The mode of connection between the master and client switches takes place through Radio frequency. So basically, Master-switch takes the command from the users as input, interpret them and process the requests/ commands accordingly. For any other switches located in the client boards, the requests are first processed by the Microcontroller, and sent via mode of wireless connection through the RF transceiver module to the client side, which is interpreted later to generate/ operate the required switches/ relays accordingly. For the gesture detection, every switch individually comes fitted with its own obstruction sensing module, which is activated all the time. Within a fixed range, any user can access that switch and operate it according to their own choice.

## V. METHODOLOGY

### A. Touch-less-Gesture sensing switches

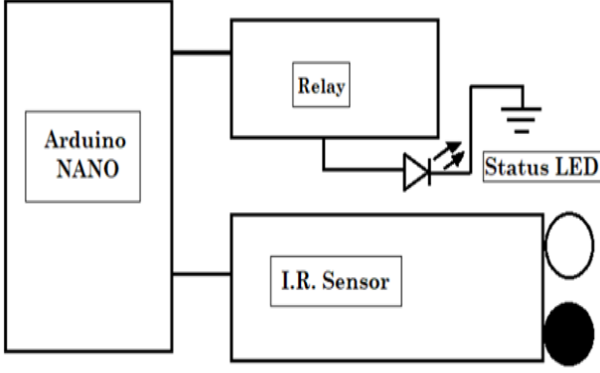


Fig. 2. Touchless gesture sensing switches

The working of IR sensor is based on emission and detection of light waves (Infrared range) for the motive of sensing any obstruction/ physical activity in its range. Any ideal IR sensor has three operating pins, out of which two are DC supply pins (+5V, Ground), while the third pin is the OUTPUT pin Which is used as source of acknowledgment about any changes/ detection made by IR sensor. This pin, is directly fed into the referred Microcontroller (Arduino NANO), which initiates the processes/ requests as programmed into it. For this system, the IR sensor is used to sense up to 3-4 cm, for any gestures/ movements made by the user. After sensing any gesture/ obstruction, it initiates the microcontroller to update/ toggle the relay status from LOW to HIGH or vice versa. The sensitivity of IR sensor can be changed using adjustment of an inbuilt potentiometer (present in the sensor itself). Every switch has an individual IR sensor, which has an active connection all the time, in order to be accessible by user. The Status LED shown in the figure above basically depicts an indicating LED (physically present above the switches on the panel), with the function to indicate which switch/ relay is active. For any active switch, the input of LED gets HIGH, and the LED turns ON and vice versa happens for OFF/ Deactivated state. By default, this LED is kept LOW to indicate that switches are in OFF state.

### B. Voice Assistant-Enabled Master-Switch

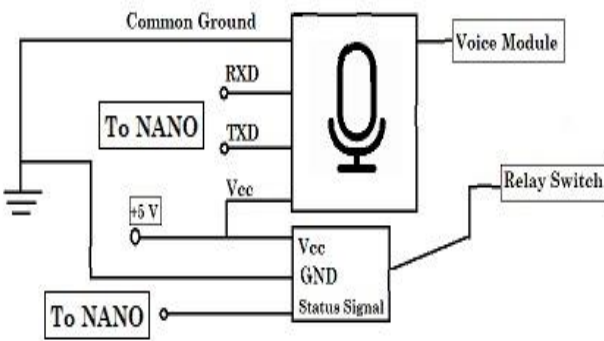


Fig. 3. Voice assistant enabled master-switch

A Master-Switch is an integrated circuit, which is enabled with Voice Module, RF Transceiver Module, Microcontroller (NANO), Touchless Switches and Relays. The Master-Switch serves as the direct mode of command recognition from the user (through Voice Command). The proposed Voice module [6] has an ability to store and recognize up to 15 different commands (As specified by user earlier). The basic working takes place by the conversion of the user-given voice commands into Hexadecimal values, which are compared/ interpreted to initiate the corresponding process. Every command has its own Hexadecimal value associated with it, which is later used for comparison. The proposed Voice Module is a DC driven module, consisting of four different operating pins. Out of these four, two are the DC supply pins (+5v, Ground), while the other two pins are Rx/D and Tx/D pins, which represent the receiving/ transmitting pin respectively.

### C. Wireless Transmission of data in between Master-Switch and Client-Switch

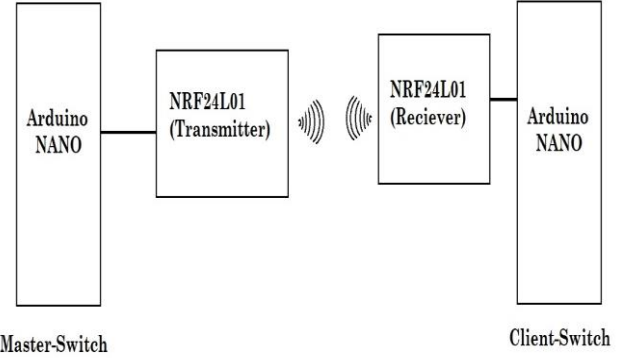


Fig. 4. Wireless transmission of data

A Master-Switch doesn't support all the direct connections enabled in the room, neither the Client-Switches support the voice assist feature. For accessing any device/port (located in client switch), by giving Voice command, there is a need to transmit the command received by the Voice module, to the required microcontroller (Arduino NANO). For this transmission, a wireless RF Module, named NRF24L01 [7] is used.

An NRF24L01 module (also referred as RF transceiver module) basically supports wireless communication with other NRF modules located in different switches. It is having a baud-rate of 250 Kbps to 2 Mbps. A basic NRF24L01 module is supported by eight operating pins, out of which, two are DC supply pins (+3.3V, Ground), three pins being SPI's (C.E, CSN, SCK), and rest pins are to be connected to digital pins of the Microcontroller (NANO). With good baud-rate, this device is highly efficient for transmission/ receiving the signals and can interact with up to six different NRF modules at the same time. The tested range for this module to operate is approximately 100 meters [8]. However, any considerable physical obstruction in between might lead to weakened connection, for the cases like this, a PA module can be used to enhance the range. Besides, for keeping the operation centralized throughout the space, there is a need of feedback/ update signals to keep an active interaction in between the controllers, and deliver minimum response time to user commands, to enhance their experience.

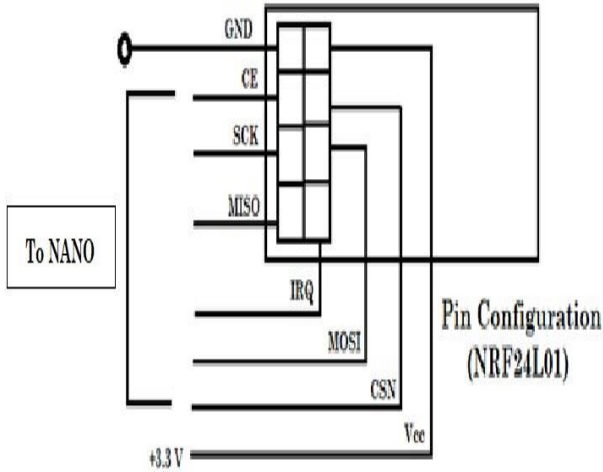


Fig. 5. Pin Configuration

#### D. Switch Board Status LED

The above diagram illustrates the connections for the status LED, which basically is used to highlight which switch is ON or OFF. For any Switch in ON mode, the input of the LED gets high, which enables the flow of power supply (DC) through it. So for every individual switch, a separate LED is present, which gets HIGH (glows) when switch is in ON position, and by default, is LOW. Since the IR sensor has a very high range of wavelength to operate on (Infrared Region) i.e., (700 to 1050 nm), so the working of IR sensor isn't affected by emission of these status LED's, which work in visible wavelength. The status LED's here operates in green region, having wavelength of 520-560 nm. Apart from that, majority of the Relays have inbuilt LED's which can also be used to detect their status, whether ON or OFF, however, due to their small size, they cannot be used for notifying purpose.

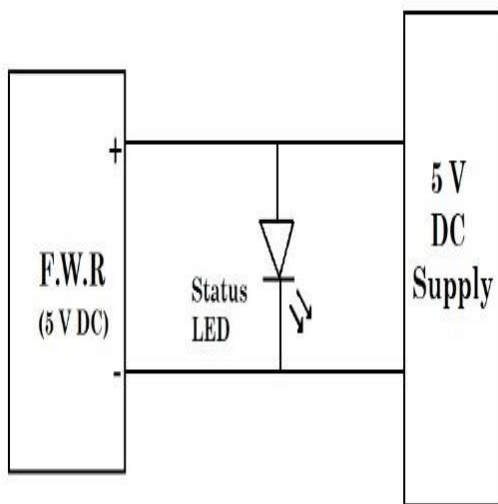
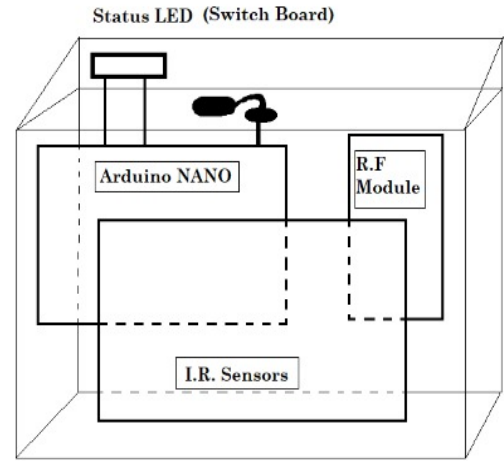


Fig. 6. Switch Board status LED

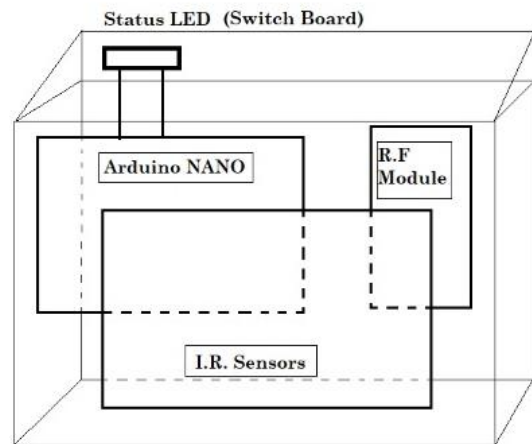
#### E. Master and Client Switches

Basically, Master and Client switches are similar, if looked structure-wise, however, the main difference between them is based on their working, the Master-Switch comes enabled with Microphone, and it is the only medium for getting the voice commands through user, Master-Switch basically is a centralized working station (for this system), when it comes on functionality differences between the two. So the Master-Switch takes in the command, processes it, and forwards it to the required port (for case of wireless transmission). For the case of physical appearance, both switches have the same look, and same physical geometry. Both switches come enabled with Switch board status LED's, which is used to indicate about the status of working of the board. This pin is kept HIGH by default, to indicate that the power-supply and Microcontroller are running correctly, for the case of failure of NANO or termination of Power supply, this pin gets disabled and turns off, which can be used as indication to know about status of working of NANO and Power supply.



### Master-Switch

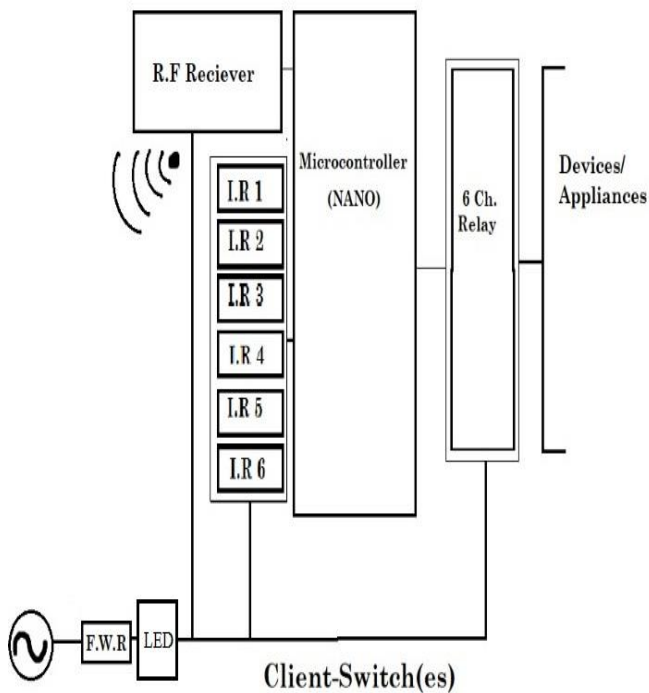
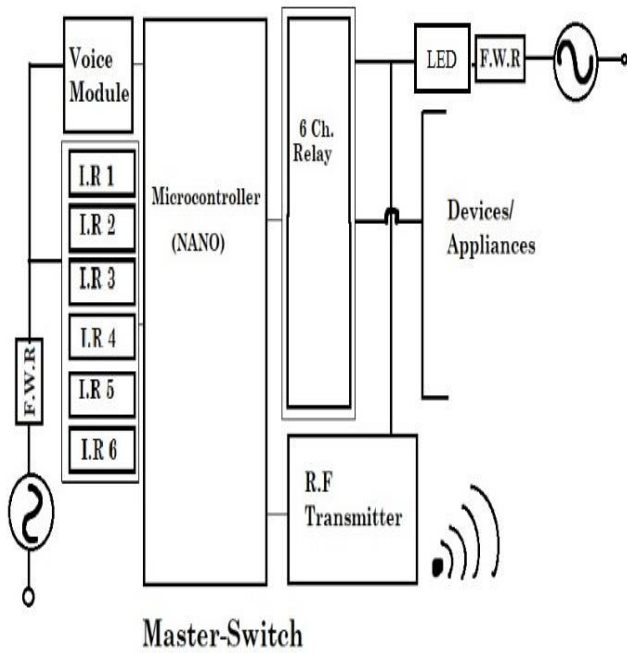
Fig. 7. Master switch



### Client-Switch

Fig. 8. Client switch

## VI. BLOCK DIAGRAM



## VII. FUTURE SCOPE

Technology has always been an interesting topic for research and development, and so is the automation. Since the concept of automation was introduced, it has been making tremendous advancements. The above concept is aimed for making the lifestyle of people better and give them easy access over devices. For the future, this field will surely serve as a wide domain for research. With growing technology, better/ advanced modules can be replaced with existing modules, in order to make it more convenient, and advanced. For the research over this field, many topics like improvement of sensing range, giving a better user-friendly interface and last but not the least, improvising the security by implementing processes like Authentication etc., for user verification (mainly focusing for security of the house) will help it make more appealing and advanced.

## VIII. CONCLUSION

The main aim for this project is to ensure better lifestyle, easy access and user-friendly interface for the people. For the usage, surely any person can operate the voice commands without even moving physically, especially for blind or physically disabled people, this feature ensures ease of access and better lifestyle, talking about the gesture switch, since there is no contact in between the finger and switch, no one needs to worry about electric shocks, and even any transfer of germs from any contaminated surface switch, which ensures safety offered by this project. Apart from that, since no contact is needed for switching purpose, neither any connection is to be ensured between the devices before getting started, and by providing centralized working of the system, this system undoubtedly ensures user-friendly experience.

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