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## **MOBILE-ENABLED HOME AUTOMATION SYSTEM VIA BLUETOOTH AND ARDUINO INTEGRATION**

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**ABSTRACT:** Smart home technology has surged in popularity, yet many existing systems are costly and require full equipment replacement. This paper presents a cost-effective method to modernize legacy home appliances by adding voice command functionality. Targeting the needs of elderly and handicapped individuals, the proposed framework minimizes technological barriers. The system is able to interpret speech commands and trigger relevant actions on connected devices by using an android mobile phone with a Local Home automation system through Bluetooth. This solution offers accessibility and affordability, enhancing the quality of life for diverse user demographics.

**Keywords:** Arduino Nano, AMR\_Voice application, Bluetooth module, Relay module.

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### **I. INTRODUCTION**

All the electrical appliances can be controlled by voice commands through Voice controlled Home Automation technology. This technology can be especially helpful for elderly or physically disabled individuals. The system runs on wireless, allowing voice commands to be transmitted from a phone to switch off appliances. Energy savings, increased security, and increased user convenience are the benefits of smart home automation. Smart switches, fans, and lightbulbs are designed to consume less energy, helping to lower utility costs. Additionally, many home automation systems offer technologies for increased safety and

security, providing users with peace of mind. Overall, home automation can be very convenient by allowing users to carry out tasks independently. This project is majorly useful for old and physically disabled people. This project uses a smartphone through which voice commands are transmitted and switches on/off the appliance according to the command without necessarily being close to the appliances.

This project works on wireless technology. Wireless technology involves transmitting electromagnetic signals over the air without physical contact.[1]

In general, energy savings, home security, and user convenience are the benefits of smart home automation.

- a. Energy Savings: Smart switches, fans, and lightbulbs consume less energy and lower utility costs.
- b. Safety of the Home: The greatest technologies for home security are offered by several home automation systems. Users purchase these devices to increase safety and security in their homes.
- c. User Convenient: End users find home automation very convenient as it allows them to carry out their roles independently.

The use of technology to carry out tasks with minimal human input or effort is referred to as automation. Smartphones are the best platform for computing the speech recognition process. Speech recognition involves any continuous audio speech that can be simply supplied using automatic voice recognition, which then produces the text equivalent.[2]

The design of this method Uses Arduino Nano, Bluetooth module, Relay, and Android AMR\_voice app.[3] Bluetooth module in the smartphone transmits the commands from Android to the Arduino Nano.

In Arduino Nano, the Bluetooth module receives the signal and then processes the input signal.[4] Android voice application is used to convert voice commands to text commands and HC-05 module is used to communicate wirelessly between smartphone and Arduino [ 3].

## II. SYSTEM OVERVIEW

In order to maintain low cost and ease of use, the entire project has been developed on an open-source Arduino platform. For the programming part, the Arduino IDE is used. Figure 1 shows the system diagram.



Figure 1: System diagram

This project is mainly composed of two sections, namely hardware and software. Software section has the AMR\_voice app which is installed on a smartphone as shown in the figure. The hardware section consists of a Bluetooth module, Arduino Nano, 4-channel Relay module (Active-LOW). As the relay is actively low, the output pins that are assigned to various devices should be set to high while programming in the Arduino (IDE).

AMR\_voice is a speech recognition app developed by SimpleLabsIN [5], that uses speech recognition Application Programming Interface of Google to convert speech (which is recorded from the microphone of a Smartphone) to Text and transmits this text to Arduino through Bluetooth by serial communication. The data that was sent has a transmission rate of 9600 baud rate. It takes between 2 and 3 seconds for the command to be recognized.

As the Bluetooth technology is used here to transmit the data, pairing of devices should be done before giving commands through the AMR\_voice app. When the power is switched ON the Bluetooth module (HC-05) starts blinking indicating that it is in discovery mode. Whenever the Bluetooth module is in discovery mode it searches for devices that are available for pairing. If the device is successfully paired, the indicator will stop blinking indicating that the pairing between the mobile and Bluetooth module is established successfully. When the commands are given to the AMR\_voice app as shown in fig., it converts from speech to text and transmits this text to Arduino Via Bluetooth. There is a specific format for the string that is transmitted.

\* {voice command} #

The Bluetooth receives this data and sends it to Arduino through Serial Communication. The string that is received will be compared with the commands that are incorporated in the programming part. If the string matches, then the output of that particular pin of Arduino (pins are assigned while programming the Arduino) is toggled to low. When the relay receives a low signal, it will be turned on as the Arduino output pin is connected to the input pin of the relay module. Then the device or appliance that is connected to that relay will be Turned ON. Similarly, we can turn OFF the devices too.

In this way, the project uses Bluetooth technology to transmit information between these devices. As the project is made to operate without Wi-Fi or internet, the connection will be stable and seamless with the added advantage of Low cost.

### III. METHODOLOGY

The project has two important parts which are:

- Software part
- Hardware part

The software part consists of AMR\_voice (Adaptive Multi-Rate) and Arduino integrated development environment (IDE). AMR\_voice application is installed on the Android phone as shown in Fig.2, and Arduino IDE installed on the laptop. Hardware part consists of Arduino Nano, Relay Module and HC-05.

**Hardware part:**

The Hardware section part consists of the hardware parts of the project. It consists of four hardware components i.e., Bluetooth module(HC-05), Arduino Nano which consists of ATmega328P microcontroller, and Relay module. The Arduino Nano is communicating with the AMR\_voice app on a smartphone using Bluetooth technology.

The main controller of this project is the Arduino Nano, and a HC-05 module for Wireless Communication with Microcontrollers and Smartphone.

**Arduino:**

The ATmega328P is primarily the basis of the Arduino Nano microcontroller. It's got 14 Digital Output Pins, which can be used as PWM or analog outputs, 6 Analog inputs and a 16 MHz Crystal Oscillator.



Fig 2: Arduino Nano

**HC-05 Module:**

It's a tool for connecting mobile phones and microcontrollers. The specifications of HC-05 module are –

- Default baud rate:4800
- Default pin:1234
- Operating voltage: 3.3V

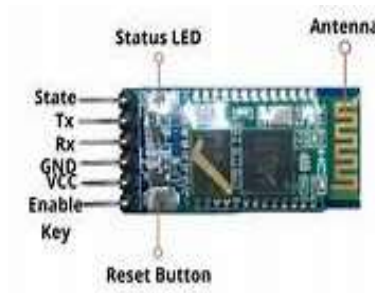


Fig 3: HC-05 Bluetooth Module

**Relay Module:**

A relay is an electrical switch that can be switched on and off by the application of a voltage across its contacts. It turns ON when the input gets low signal.



Fig 4: 4 -channel Relay Module

**Software part:**

- In this Software section, Arduino Integrated Development Environment (IDE) and AMR\_voice app is utilised.
- The Android platform has assistance, which permits a tool to wirelessly trade information with different devices.
- The utility substructure offers entry to Bluetooth capability via the Android Bluetooth APPs. The project is sectionalised into software and hardware. The software section includes the AMR\_voice (Adaptive Multi-Rate) application and Arduino IDE. You must install the AMR\_Voice application on your android phone as shown in Figure 5 for this software to work, while the Arduino IDE needs to be installed on a laptop.

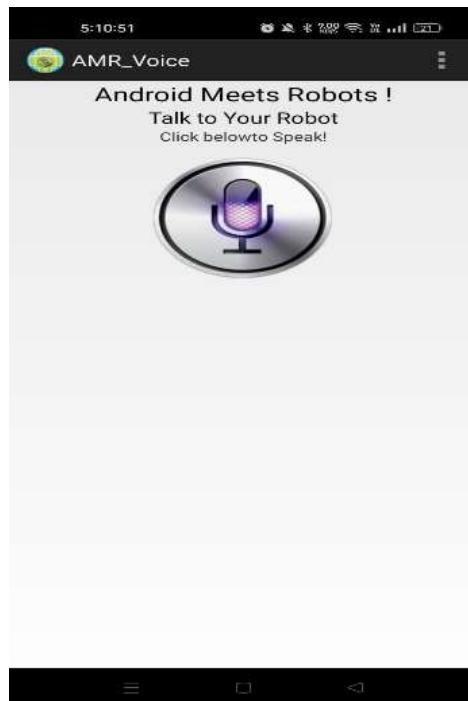


Fig 5: AMR\_Voice Application Interface

### IV. ALGORITHM FOR COMMAND RECOGNITION

The app sends the command via Bluetooth. The system does not require that the command obtained be a special statement which can be regarded as having validity. Instead, it utilizes a keyword search method to identify the necessary words that constitute a command.[5] This approach enhances the system's flexibility from the user's perspective. A buffer of 10 words is used to process the command sentence. These words are compared with the words that are stored before. When the compared words are same then they are flagged. The command is then interpreted using these flags. For example, if the command contains the words "switch", "off", and "light", regardless of their order or the presence of other words, it indicates the intention to switch off the light.

Figure 6 depicts a flow chart for this algorithm:

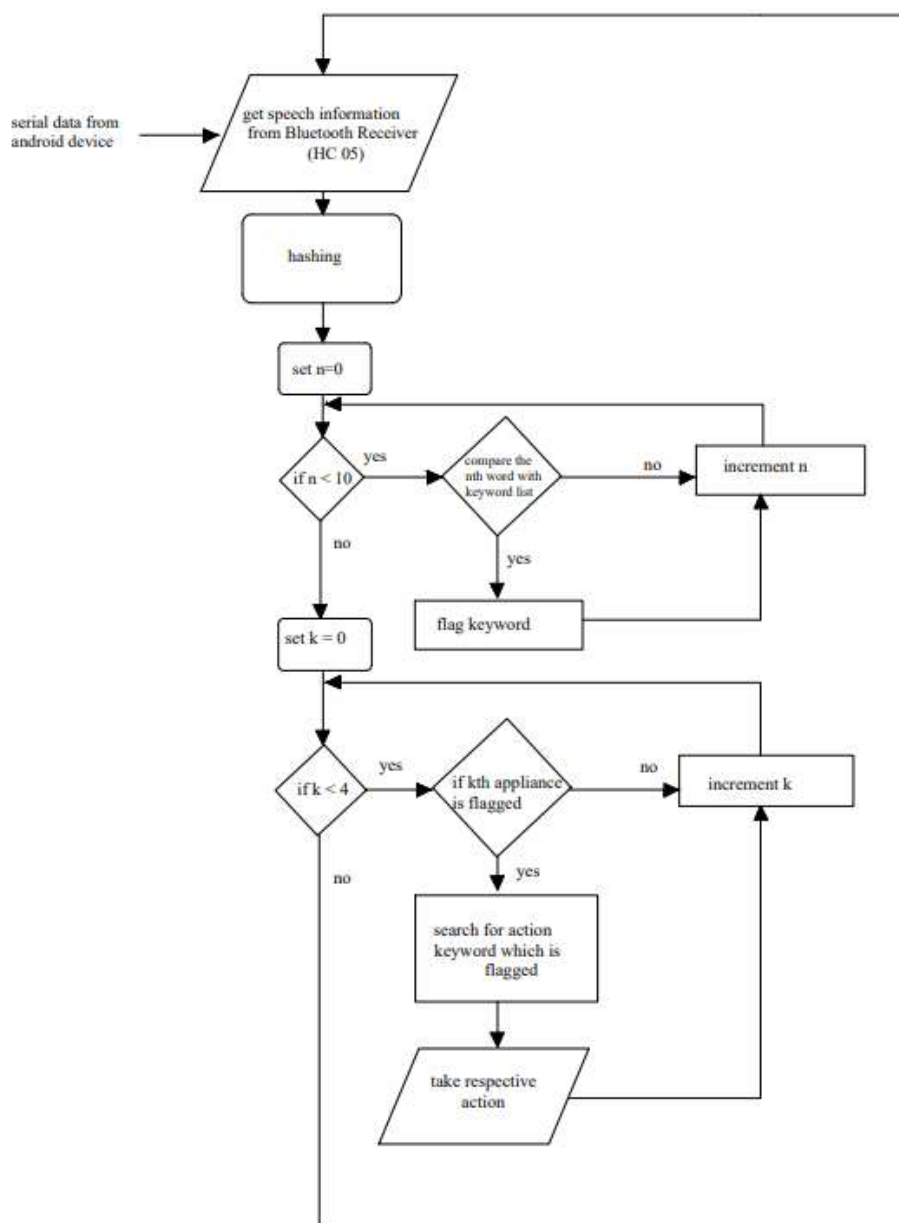


Figure 6: Algorithm's flowchart

#### IV. RESULTS AND DISCUSSIONS

The project is tested on hardware using Arduino Nano, HC-05, and Relay Module. The relay module's indicator indicates whether the relay is ON or OFF. When it is turned ON, the home appliances will be switched ON and vice-versa. The AMR-voice is installed in our smartphone. HC-05's Transmit Data and Receive Data pins were connected to D2 and D3 of Arduino nano, the D2 pin acts as RXD, and the D3 pin acts as TXD. The data transmitted through the Bluetooth module must be received by Arduino nano, the D2 pin act as RXD, and the D3 pin act as TXD in Arduino nano.

We can choose any digital pin of your choice in Arduino nano but you need to write in the program.

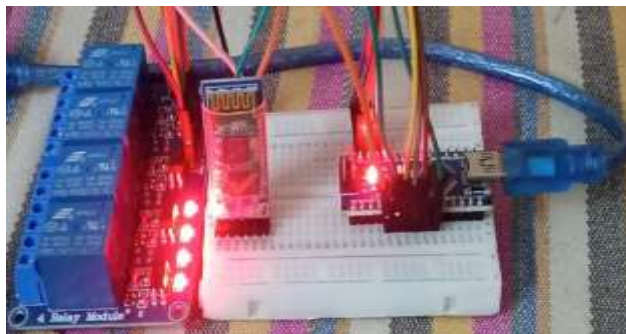
The function is:

**SoftwareSerial mySerial (RX-Pin, TX-Pin);**

while RX-Pin=2 and TX-Pin=3

The 5V and GND pins of the Arduino Nano have been plugged into VCC and ground pins on the Bluetooth module. The digital output pins (4,5,6,7) were connected to input pins of the 4-channel Relay Module to activate the home appliances.

The AMR\_Voice application has been placed on the phone and a Bluetooth wireless connection between it and an Arduino Nano was set up. In silence and noise environments, the AMR\_Voice app has been analysed and tested for accuracy.



The accuracy of the voice app can be referred to in table 1 below:

Testing Method	Distance (in cm)	Number of devices	Device response	Output Accuracy (in %)
Silent place	100	4	4	100
Noisy place	100	4	3	75
Silent place	200	4	3	75
Noisy place	200	4	3	74.5
Silent place	500	4	4	100
Noisy place	500	4	2	50
Silent place	1000	4	3	72
Noisy place	1000	4	3	73
Silent place	1500	4	4	100
Noisy place	2000	4	3	60

## V. CONCLUSION

The range of the HC-05 Bluetooth Module has been calculated by turning on and off home appliances using the AMR\_voice app in both silent and noisy places within the range where the Bluetooth module receives data from mobile. 20m is the range for HC-05 module. When all four devices were responded to, the accuracy of the voice application was 100%. Due to noise 3 out of 4 devices responded, and the accuracy of the app calculated 75% in noise places. Therefore, the accuracy of AMR\_voice app is essential to its output quality.

## VI. REFERENCES

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