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VOICE COMMAND TELEVISION REMOTE CONTROL USING ARDUINO MICROCONTROLLER

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Abstract: A television (TV) set is one of the most owned communication devices found in almost all home. They are usually sold with IR remote control used to operate the various function of the TV set. One problem associated with the use of IR remote control is that it is a line-of-sight device and cannot be operated from some specific relaxation spot. The distance of operation is small and can easily be interrupted by a person or object. Another challenge is the inability of the user to remember the channel number of their favourite TV stations. Also, disabled and less privileged persons will face challenges in using the IR remote. This research work seeks to eliminate these problems by designing a remote control that can operate with the use of voice command from any smart device. This was made possible using a Bluetooth enable smart phone with a voice recognition app installed. The voice command was converted into text format and sent to an Arduino microcontroller via a Bluetooth module. The processed information by the Arduino microcontroller was used to send out infrared signal through an IR transmitter to the TV in order to control the TV functions.
Keywords: IR TV remote, Bluetooth Module, Arduino Microcontroller, Smart Phone, IR Transmitter.

INTRODUCTION

The world is said to be a global place with advance in technology. Humans, due to curiosity has embarked into series of research in a bid to harness the natural resources around them with the help of science and technology in order to enjoy the best life can offer and make human activities easier. The entertainment and information sharing is an essential activity in human existence hence early inventors developed electronic devices such as Radio and Television set to help share information between distance places and also give pleasure, amusement and a means of relaxation at home or office without going out to seek for them. TV set is one of the most used entertainment boxes for homes, offices and hospital. They are manufactured in different types and size which in the early days were just black and white images with a vacuum tube at its back. With advancement in technology, bigger sizes of TV set with coloured images and a flat back are being produced on daily basics. In a room (like the sitting room of a living house), the TV set is usually placed in a position where it can be easily viewed by all (usually at the front-central part of the room close to the wall). Alongside the TV set is a remote control used to easy the operation of the TV set without going to it. Early remote-control design was wired as used by most Video recorder which posed much discomfort and trip and fall incidents hence a RF wireless and Ultrasonic remote were made and then the Infra-red (IR) remote control was invented (Nathan, 2011).

The IR remote control is used to control a device wirelessly by transmitting signal at different frequencies through an infrared transmitter in the remote control and received by an infrared receiver place in the device circuitry. The IR remote control device has its own setbacks at is suffers from Line of Sight (L.O.S) effect. With this, it cannot be operated from all convenient position (especially when someone is seated at the side). Also, Elderly and disabled person found in homes and hospital will find it difficult to operate the IR remote control as they may be subjected to a learn process or may be handicap to press the keys on the remote control. Little children at home are always very curious with what parents do with a remote control and therefore always pick up the remote control to key in undesired button or most case place the remote where is can't be easily

found if not destroying it in the process of playing with it. Also, it is usually difficult to remember the channel number of various TV stations available hence the search for a favourite station is time consuming.
This project research is intended to eliminate the setbacks associated with the use of IR remote control for TV set. This can be done by designing a system that can control the activities and functions of the TV set using voice command. The design consists of a smart phone which is bluetooth enabled with a speech/voice recognition application. The analogue input voice signal will be converted to digital signal and sent to a microcontroller through the bluetooth pairing technology. The microcontroller will process the received signal and use the information processed based on its program to send out infrared signal through an IR transmitter to the TV set in order to control the TV function just like the regular TV remote.
This research design will provide solutions to line-of-sight effect associated with infrared devices, enable easily operated by both the elderly and the disabled persons, eliminate the use of key/buttons, provide a possibility for remote duplicate, reduce the interruption of programs watched when remote is handled by children, eliminate interference and obstruction of remote operation by persons or objects.

LITERATURE REVIEW

Haque, Kamruzzaman and Islam (2010) did a research work which deals with controlling appliances based on timer and speech recognition. It showed the design of an interface box that can be controlled by the computer which is connected to parallel port. The system architecture involves the use of two units: a control unit and an interface unit. The timer option of the system was discussed as well as voice control option to control home appliances. In their hardware design, they have shown how to interface a relay and AC load which can handle eight electric appliances at once. They made use of Visual Basic 6.0 and Microsoft voice engine tools for speech recognition purpose.

In a project work carried out by Faisal, Saira and Muhammad focused on remotely controlling appliances in a home using wireless communication linked to the home. The work discusses two methods of controlling home appliances; one is through the use of voice to text SMS and other is the use of the mobile device as a remote control. The system designed will be of great benefit to the elderly and disable people and also to those who are unaware of typing an SMS. Their design made use of an android device, which can convert the voice command into text using android intent API 2.01. The commands generated are appended in SMS which is sent through GSM network. A Bluetooth module receives the text from the android device and sends it to a PIC16F877A development kit (Faisal *et al*., 2012).

The development of low-cost remote home control system using speech recognition and Bluetooth module HC05 was used in controlling fan, lamp and other electrical appliances. The voice command from the user which is an analogue input is been accepted by the main control unit and fed to an Arduino Microcontroller. Arduino senses the input signal, processes it and give instructions to the relay which in turn turns On/OFF the electrical loads (Manoj *et al*., 2017).

Jinan (2019) carried out a project design on home automation system using infrared technology and voice commands which was based on a voice recognition system that made use of the voice recognition unit V3. The voice recognition unit V3 has the ability to recognize voice commands, convert them to a desired data coordination and data transmission through IR transmitter and Arduino microcontroller. The signal is to be received by IR sensor to control TV receiver which gives a full remote control that works by voice commands.

The software consists of a Micro C language programmable microcontroller. It is aimed at helping people with special needs or physical disabilities and injuries by paralysis to control any device.

An article from electronics foru written by Ashwini reported the design of a voice and Google assistant remote control. In that article, he pointed out that remembering a TV channel number is part of the problems of using the regular IR remote. In order to get rid of this issue, a decision to make a smart remote that operates using voice commands was conceived. The project requires retrieving the RAW or HEX code from a TV remote control. However, this step was eliminated as the remote codes for each button was obtained from the internet. Programing languages such as Raspberry Pi, Python and Arduino sketch code were used to set voice command in to a voice kit and the Arduino microcontroller system. The system made use of an IR transmitter to send the information from the Arduino to the TV set (Ashwini, 2020).

Mok and Karna (2019) did a design on voice recognition system for home automation. In their report, they said voice recognition system is the process that a physical device can be controlled by recognizing the voice of the speaker or user. The project proposed the use of Geeetech voice recognition module which is used to record and import the instructions or commands that is used to control the basic function of the physical devices. With the help of Arduino Uno, the physical devices can be controlled through the speaker's voice.

DESIGN METHODOLOGY

This design of a voice control TV remote is carried out in two different sections, the data collection section and the control implementation section. Each section is divided into two parts; the hardware design and the software design methodology.

Hardware Design

The hardware design consist of all hardware components put together to achieve this project design for both sections. The design block diagram shown in Fig. 1 and Fig. 2 will be used to explain the working of the entire setup and this will be discussed in stages of construction as seen in the subsections below.

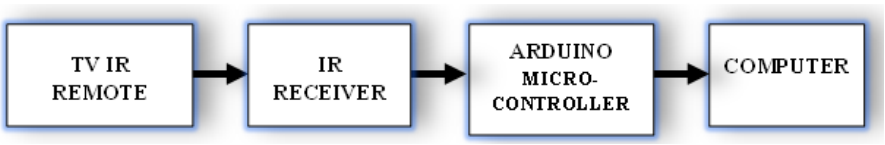


Fig. 1: Block diagram for date collection section

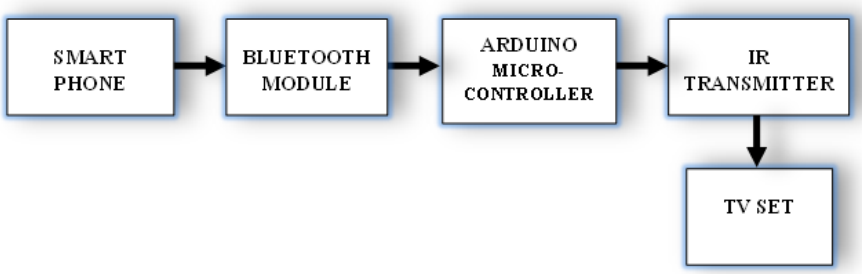


Fig. 2: Block diagram for voice control implementation section

From the block diagrams above, the project design can be divided into the following; Data collection section and voice control implementation section

Data Collection Section

This section is the section that has to deal with collection of information that will be used to implement the voice control design section. This requires obtaining the information from the TV remote and using the information to program the final remote-control setup. This is done in the following stages

- Receiving stage
- Processing stage
- Data storage stage

Receiving stage

The Receiving stage of this design consists of hardware materials that generates the information to be stored which is been received by the system. It is made up of two devices:

- TV IR remote control
- IR Receiver

TV IR remote control: The TV IR remote control is a small handheld device that is used to control the activities of the TV set from a short distance and it is operated wirelessly. It consists of button which serves different functions when press. The remote control has in infrared transmitter which sends out infrared rays to be received by the TV set infrared receiver. When a button is pressed on the remote, an electromagnetic signal (infrared) is transmitted from the remote and its information decoded by the receiving device. The IR remote pulse this invisible light (signal) in binary code (Ryan, 2022). Each button or command has a specific binary code they generate when pressed which may include Power on/off, channel up/down, volume up/down etc. for example, the volume up for Sony TV is shown in Fig. 3 below.

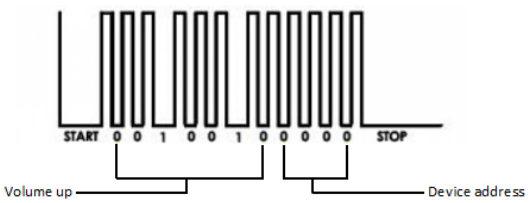


Fig. 3: Volume up for Sony TV

In this setup, an LG TV IR remote control is used. This IR remote control has 48 buttons. When the buttons are pressed, the different binary code been sent from the remote control is received by the IR receiver.

IR Receiver: The IR receiver as the name implies is a device that receives the electromagnetic signal sent from an IR transmitter. It receives the different code sent from the IR transmitter and sends this information a processing unit where it can be decoded by the system. The IR receiver used in this project design is the TSOP 1738 IR receiver [see Fig. 4]

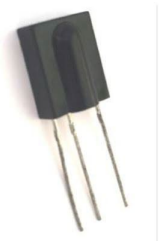


Fig. 4: TSOP 1738 IR receiver

It consists of three pins (Vcc, GND and Signal). The Vcc and GND are the power pins of the device and are connected to a +5V and GND source respectively. The Signal pin (S) is used to transmit the signal received to the processing device.

Processing Stage

The processing stage of this design involves the use of a microcontroller to process the information received from the IR receiver. After receiving the code of the different buttons pressed from the TV remote control, the information is then stored or saved to be used later. The microcontroller used in this project is the Arduino UNO microcontroller. It is a mini-computer that interacts with the physical world more than an ordinary computer [see Fig. 5].



Fig. 5: Arduino UNO microcontroller board

The microcontroller is a programmable device which when programmed acts accordingly as specified by the programmer. An Arduino program (sketch code) is being written, verified and uploaded from a computer into the Arduino microcontroller board. This sketch code aids the microcontroller to communicate with the IR receiver and converts the various binary code received by the IR receiver into hexadecimal codes.

Data Storage Stage

This stage consists of just a Personal Computer (PC) which is used to store the information processed by the Arduino microcontroller. When the Serial monitor on the Integrated Development Environment (IDE) is opened, the hexadecimal code for each processed code is displayed on the PC monitor screen. This information is then copied and saved on a Microsoft word as shown in Table 1 for some of the LG TV remote keys.

TABLE I: TV IR REMOTE KEY TO HEXADECIMAL CODE

TV REMOTE CONTROL KEY	HEXADECIMAL CODE	TV REMOTE CONTROL KEY	HEXADECIMAL CODE
0	20DF05F7	Input	20DFD02F

1	20DF8877	Okay	20DF22DD
2	20DF48B7	Volume up	20DF40BF
3	20DFC837	Volume down	20DFC03F
4	20DF28D7	Channel up	20DF00FF
5	20DFA857	Channel down	20DF607F
6	20DF6897	Up	20DF02FD
7	20DFE817	Down	20DF827D
8	20DF18E7	Left	20DFE01F
9	20DF9867	Right	20DF609F
On/Off	20DF10EF	Exit	20DFDA25

The power used to power up the system at this stage is obtained from the PC system via the USB connection. The circuit diagram for that data collection section of this project design is shown in Fig. 6 below.

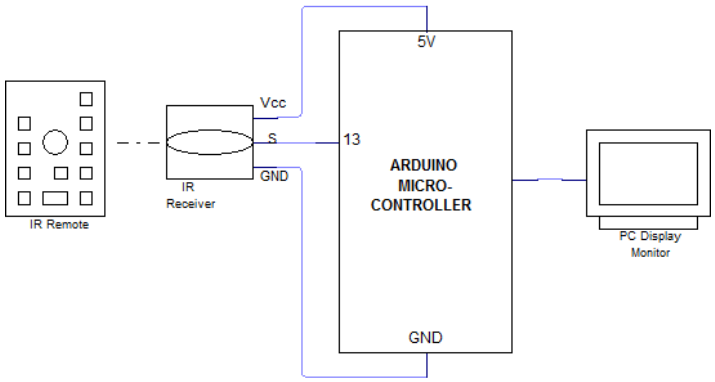


Fig. 6: Circuit diagram for Data collection

Voice Implementation Section

This section of the project design consists of hardware connection that will use voice command to control a TV set. The information hexadecimal code obtained from the data collection section will be used to program a microcontroller with a corresponding voice command. This section can be divided also into

- Transmission stage
- Receiving stage
- Processing stage
- Output stage
- Power supply

Transmission stage

This stage serves as an input to the system. It is made up of a smartphone that is bluetooth enabled and has the ability to install an app that is verified by Google play and download from the Google play store. The application used for this this design is the Arduino AMR voice command app. This application has the ability to listen and record voice note then convert the voice note to text. This is made possible with the help of the Google voice recognition software that is installed with the phone's operating system. Voice recognition systems enable us to interact with the phone simply by speaking to it, enabling hands-free requests, reminders and other simple tasks. It requires that analogue audio be converted into digital signals. For the system to

decipher a signal, it must have a digital database, or vocabulary, of words or syllables, as well as a speedy means for comparing this data to signals. The speech patterns are stored on the hard drive and loaded into the memory when the program is run. The converted text is then transmitted from the smart phone to the microcontroller wirelessly by making use of the bluetooth technology.

Receiving Stage

The receiving stage of this design receives the data/information send from the smart phone. It made up of just the Bluetooth module which establishes a connection to the mobile smartphone. The bluetooth module used for this project is the HC-06 bluetooth module [see Fig. 7].

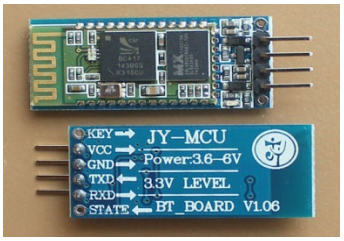


Fig. 7: HC-06 Bluetooth Module

The HC-06 module has four useful pins (Vcc, GND, Tx and Rx). The Vcc and GND pins are the power supply pins which are connect to +5V and GND of the microcontroller respectively. The Tx and Rx are the transmitting and receiving pins of the module respectively used to communicate with microcontroller. The Tx pin is connected to the Rx pin of the microcontroller while the Rx pin of the module is connected to the Tx pin of the microcontroller. When connection is established between the smartphone and the bluetooth module, wireless communication between the smartphone and the microcontroller is made possible.

Processing Stage

The processing stage of this design also involves the use of a microcontroller to process the information received from the bluetooth module to give command to the TV set according to the command received. The microcontroller used in this project is the Arduino UNO microcontroller as described in section 3.1.1.2. As a programmable device, the converted voice note (which is now a text note) is program such that each text note corresponds to a specific hexadecimal code.

Output stage

When the convert voice note is received by the Arduino microcontroller through the bluetooth module, it is been processed to match the corresponding command according to the program. The corresponding hexadecimal code of the command received is then transmitted out of the Arduino to generate a similar electromagnetic signal (infrared) that can be decoded by the TV. This signal is sent out from the Arduino via an infrared transmitter and is received by the TV set infrared receiver.



Fig. 8: Infrared transmitter

The infrared transmitter used in this project is the 3mm LED invincible IR transmitter [see Fig. 8] with a wavelength of 940nm. It is connected to the Arduino through a 100 ohms resistor. The complete circuit diagram for a voice command TV remote is shown in Fig. 9 below.

Power Supply

For sure, all electronic devices require a form of power supply to carry out its operation. The type of power supply required by an electronic device is the DC power supply. For this prototype project design, the DC power supply provided for the operation of the system is via a 9V battery and connected to the system with the help of a battery clip with a jack

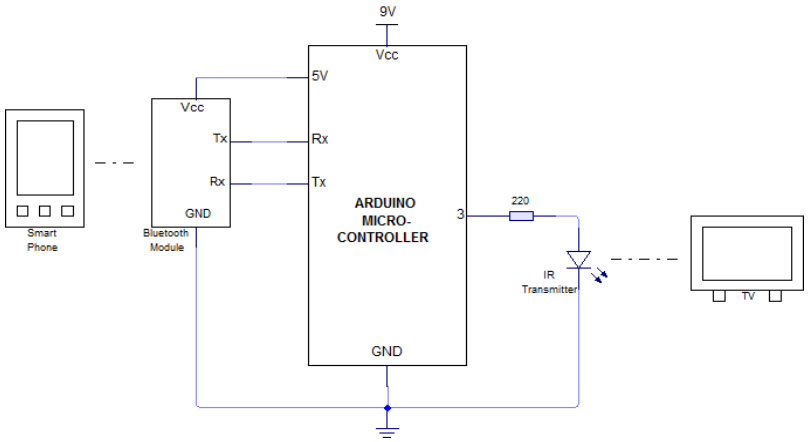


Fig. 9: Circuit diagram for a voice command TV remote control

Software Design

The software design part of this project consists of the set of code that was written with a computer and uploaded into the Arduino microcontroller. The code is called an Arduino sketch code and its command can be illustrated with the flow chart.

Flow chart

The flow chart will be used to illustrate creativity and idea initiated in the Arduino sketch code that was uploaded into the microcontroller. It gives details of the processing processes of the Arduino microcontroller when information is received. The information received is the text code obtained from the conversion of voice command to corresponding text code by the smart phone. The text code is sent to the microcontroller via bluetooth and the flow chart is show in Fig. 10 below.

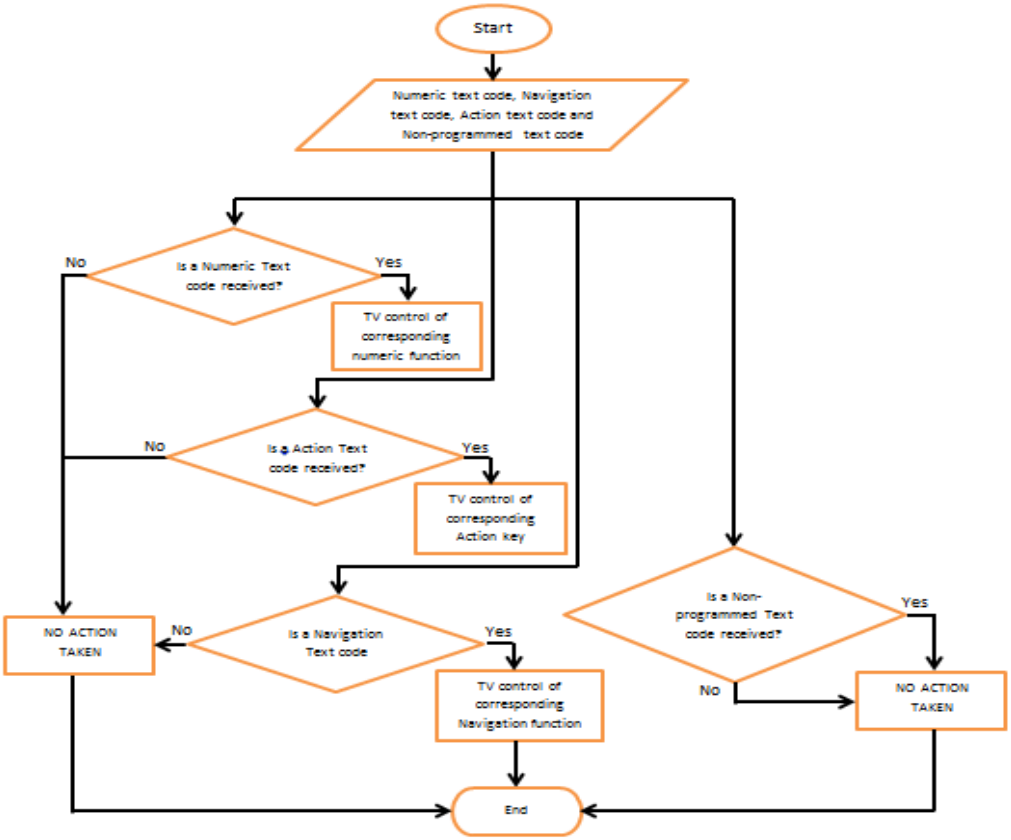


Fig. 10: Program flow chart

RESULT ANALYSIS

The data table below in Table II shows the result obtained from different possible conditions at which constructed project was tested. It was obtained by taking record of the voice command that will be said, the converted text that is sent from the smart phone and also if the function as specified is executed or carried out by the TV set at different range of operation.

TABLE III: RESULT DATA TABLE FOR THE CONSTRUCTED WORK

Condition	Operation Range (m)	Voice Command	Converted Text (Send)	Text Processing Status (received)	IR remote Command Function	Is Function executed by TV set?
1	<10	ON	On	True	ON TV	Yes
2	<10	OFF	Off	True	OFF TV	Yes
3	<10	ON	Oh	True	ON TV	Yes
4	<10	1	1	True	Enter 1	Yes
5	<10	2	Too	True	Enter 2	Yes
6	<10	3	Tree	True	Enter 3	Yes
7	<10	4	For	True	Enter 4	Yes
8	<10	5	5	True	Enter 5	Yes

9	<10	6	6	True	Enter 6	Yes
10	<10	7	Seven	True	Enter 7	Yes
11	<10	8	Eat	True	Enter 8	Yes
12	<10	9	Nine	True	Enter 9	Yes
13	<10	0	Zero	True	Enter 0	Yes
14	<10	Channel up	Channel up	True	CHANNEL UP	Yes
15	<10	Channel down	Tunnel down	False	CHANNEL DOWN	No
16	<10	Channel down	Channel down	True	CHANNEL DOWN	Yes
17	<10	Volume up	Valley up	True	VOLUME UP	Yes
18	<10	Volume up	Volume up	True	VOLUME UP	Yes
19	<10	Volume down	Volume down	True	VOLUME DOWN	Yes
20	<10	Input	Input	True	TV INPUT	Yes
21	<10	Left	Left	True	MOVE LEFT	Yes
22	<10	Right	Right	True	MOVE RIGHT	Yes
23	<10	Okay	Ok	True	SELECT	Yes
24	<10	Input	Input	True	TV INPUT	Yes
25	<10	Left left	Left left	False	Nil	No
26	<10	Still	Steal	False	Nil	No
27	<10	Input	Input	True	TV INPUT	Yes
28	<10	Up	Up	True	MOVE UP	Yes
29	<10	Down	Down	True	MOVE DOWN	Yes
30	<10	Back	Back	True	RETURN	Yes
31	<10	RSTV	RSTV	True	Channel 22	Yes
32	<10	NTA	NTA	True	Channel 10	Yes
33	>10	OFF	Off	Nil	OFF TV	No
34	>10	Input	Input	Nil	TV INPUT	No

From the table, it is seen that the convert text may not follow the same word as the said voice command. Meaning if the converted text is not used as part of the word to match a said command in the program code, no action will be taken.

CONCLUSION AND RECOMMENDATION

Voice command TV remote control system is system that can control the functions of a TV set just as the manufacturer's remote using voice command from the user. The design was carried out successfully by introducing advanced system of voice recognition to recognize, match and convert analogue voice into text as can be found in smart phones. The TV set control also made use of Bluetooth Module, Arduino UNO microcontroller and Infrared transmitter. To receive, process and sent out program respectively. From the above analysis we can conclude that the entire system can be built with low cost, reliable instruments thereby providing an efficient means of electronic device remote control.

For researcher, scholars and engineers who want to carry out this design and construction, I will recommend that:

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1. Addition of artificial intelligent AI such that the system can learn new voice command
2. Design an electronic device that can replace a mobile phone and still retain the voice recognition software.
3. Device can be integrated into the TV set
4. Small chip can be used to in-place of an Arduino board

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