Projecthiko 1.O - The Voice & Internet Enabled Smart Home

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Abstract*—The project is focussed towards making the lives of people easy and comfortable. But doing this generally harms the environment , hence keeping this aspect in mind, this paper is based on the project of home automation system. The automation is done using recognising the speech taken by the user and the inputs taken by user on his mobile phone which in turn should be connected to internet. The environment is also protected because all the electric and electronic components in house can be accessed remotely. This reduces the human effort and saves a lot of energy. Because now, no mother has to call her son to tell him to switch off all the lights in the house before going out of the house, as she can just say "*room lights off" or tap on the button which says the same thing. This in turn also saves a lot of money. According to some calculations, an automated house can observe a cut of 15-20 percent in electricity bill.**

I. Introduction

The name "Hiko" means electricity/elctrical in maori language. The whole project is set up to save electricity. Major list of items used here are:

Items Required
Raspberry Pi 3 Model B
Microphone
Sound Card
Light Emitting Diodes
Physical Model
Jumper/Connecting wires

Any invention/remake is done with keeping in mind the following three aspects:

1) Protects the Environment (Does no harm would also suffice)
2) Comfort for the user
3) Cost of development must be less

The elements listed below gave the motivation for making a prototype like this:

A. Protects the Environment

On an average, every house has a set of rooms in which lights are always "ON" and only because people in the house have frequent visits in the room or in the night time, it is difficult to find the switchboard when the lights are "OFF". The Television generally operates 18-19 hours continuosly in the house. And unknowingly, it utilises a lot of electrical energy. What if we have some system by which there is negligible loss? The amount of fossil fuels burnt(still a major stakeholder in terms of energy) which depletes the environment can be reduced to a favourable level. However this can only be achieved when systems like hiko are installed in most of the houses of the world.

B. Making Life Easy

Take a situation, there is a patient instructed not to move from bed. Worst thing happens if he/she lives alone. Is there a way by which he/she doesn't have to move a bit and can operate anything in the house? Yes! its hiko. Taking this situation to the life of students makes it even worse. The switchboard of the whole room is situated on a particular wall. If a student is going to sleep, due to his/her laziness, he/she doesn't switch off the light and passes this responsibility on his/her room-mate. And this thing never ends and the lights are never switched off. Consider this happening in almost 40 percent of the hostel rooms. And yes! This is a huge number. Think how good it could be if all the room-mates have a specific app installed in their mobile phones and can operate the lights and fans from that app.

C. Cost Analysis

The proposed model (a prototype) consists of 5 automated rooms, 1 Gate, 1 Fan 1 Lift. The prototype costs only Rs.4976. On adding the cost of relays, wires and adding some profit for the developer, one can sell it for Rs. 8000. This is quite cheap. Amazon Echo Dot[12] which only is a speaker comes for Rs. 10000. On installation of full home automation of Alexa, the cost goes as high as Rs. 2,00,000 or in some cases even more.

D. UI Goals

The basic idea behind hiko is developed after thinking upon these important points. The final model has to be interactive with the user. The user must *NOT* get bored of the hiko. The webapp developed to manage the house using phone must be catchy. It should also be very easy to use.

Further sections in the paper are divided with headings, how things work, features and commands, circuit diagram and explaination, pseudo code, results and conclusion.

II. HOW THINGS WORK?

A. *Devices and Items used:*

1) Pi 3 Model B: Raspberry Pi 3 Model B is a small single-board computer, originally developed by the raspberry pi foundation to promote the teaching of computer science in schools. But later students started toinvolve it in robotics and hi-end computing. The Raspberry Pi 3 Model B uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache. It runs at 1GB DDR2 RAM. Its power rating is 700mA (3.5W). It is provided with 4*USB2.0 ports which can be used to connect keyboards and mouse. It has inbuilt wifi module and bluetooth module unlike Raspberry Pi 2. Raspberry Pi 3 Model B features 802.11 b/g/n 2.4 GHz WLAN and Bluetooth modules. The Raspberry Pi has a set of GPIO(General Purpose Input Output) pins which can be programmed using the python library GPIO. We can take inputs, give outputs using these GPIO pins. It also has multiple "Ground", "5V", and "3.3V" pins mounted on it for convinience.

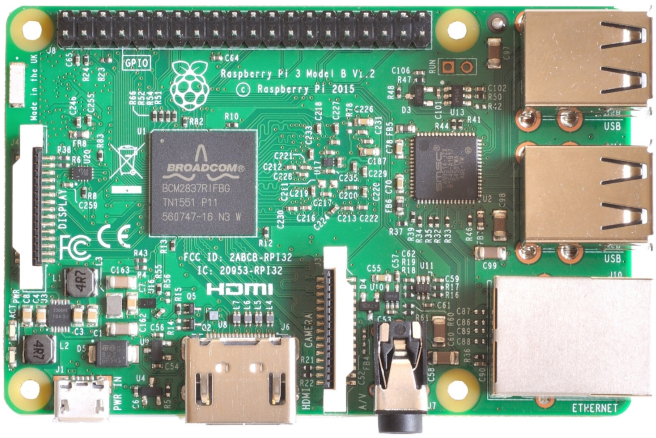


Figure 1. Raspberry Pi 3 Model B[7]

2) IC L293D: L293D[6] is a typical motor driver IC which allows the DC motor to rotate in either directions. IC L293D is a 16 pin IC which can control two motors simultaneously.It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor. We have used the motor driver to externally supply more voltage to LED's as well.

3) Sound Card: It is a simple input/output device which provides input and output to the computer when prompted by the computer programs to do so. They are DAC (Digital to Analog Converters).

Figure 2. L293D Motor Driver[6]

B. *Voice Recognition:*

Voice recognition is done using the Google Speech API[11]. API stands for Application Programming Interface. The Google Speech API provides a web link. After recording the voice sample, the voice sample gets pushed to that link, it analyses the data and converts it into text and returns the text file. Then a simple algorithm of idenitifying the text in a string written in Python3 comes into play and analyses the text and gives the suitable outputs to GPIO pins according to the inputs. Any speech API works on majorily 3 databases:

1) Acoustic Model: Analysis of type of sound. Depends on the charachteristic of the person who is speaking. This property is specific to a person.
2) Lexicon Model: Analysis of how words are formed. How they are spelled. Not specific to a particular person. In short it is Universal.
3) Language Model: Analysis of how sentences are framed using different words.

One of the major goal of home automation is to make the voice recognition universal and not specific to a single person. Because the basic access to the things in house can be given to any person in the house.
Due to this major concern, the Acoustic model of the Speech Database can not be used. Only the Lexicon and Language models must be used. There are two kind of open-source API's available. One is online, where the database in online. And the other is offline, in which the database is installed on the local device - for the project, that local device is Raspberry Pi. The online kind of API's are highly dynamic due to the fact that they can maintain a huge database. Else, local database has large numbers of setbacks due to less memory in Raspberry Pi 3 Model B (Limited to a maximum of 64 GB). The random access memory is also limited to 1GB as quated earlier.

C. *Mobile/Web Platform:*

The another key aspect of the Projecthiko1.O is the webapp which is created independently, extensively using HTML5, CSS3, JavaScript and Flask. The front-end User Interface is

developed keeping in mind the general trends of usability. The main aim is to make it interactive, user-friendly and a User Interface, which can be used by any age groups and used in any device. Best way to do is developing a webapp. This webapp's frontend is based on HTML5 and CSS3.The front-end device compatiblity is handled using JavaScript. The backend support is what makes the webapp really working. For that there are multiple executable python files which turns on and off various devices are created. A package of Apache2, php5, sqlserver is used. This package is popularly known as "LAMP[10]". Then the LAMP server comes into play. All these things are hosted on Apache2 server. The backend is accessed through flask[9], where the flask is given a particular URL to each and every button. Just on visiting the URL, the operation is performed. This gives universal access to the home.
The front-end UI is available online[8].

D. *Physical Model/Prototype:*

All these things were implemented on a physical model (prototype) which is developed to showcase the functionings. It is made up of scrap lying outside newly constructed buildings, useless wooden material, packaging boxes.

III. FEATURES OR COMMANDS

A. *Light Operations*

The lights of any room can be operated by including these three words in any order in your sentence = "lights", "state(on/off)" and "room(Name of the room)". You can speak out for e.g.: "Bedroom Lights off" and the bedroom lights would turn off. If lights were already off, it would respond with "Already Off". To turn off the lights of all the rooms, you just have to say: "good night". This phrase is quite useful because at the night time, instead of going to each room and checking whether the lights are on or off, one can just say good night. Nor would one miss any room and neither have to put efforts from his side.

B. *Fan Operations*

The Fan can be operated in the same way as light does. The only difference lies in the part where by a single command, the user turns off all the lights in the room. This case can not be with the fan due to the fact that, the user only turns on the fans when it is really required. Hence in a summer night, if we say "good night", nobody wants that the fan also gets turned off. Hence the commands like "good night" operates only on lights.

C. *Lift Operations*

The lift operates when the user speak out the floor where one wants it to be. Generally, we have to wait for the lift to come from some floor. The user constantly press the calling button. Now, what one can do is to just call out the "floor" "state(where one wants the lift to be)" in their sentence and it would come to the floor they want. It saves a lot of time.

D. *Door Operations*

On giving the input about the door and the state in which the user wants it to be, one can easily operate the door. Two phrases "door" and "state(open or close)" have to be included in the sentence. The operation will take place. This is realised using 9g Servo Motor(weight of servo motor is 9 gram) which is given the angle inputs through the GPIO pins.

E. *Keyword*

The main problem one faces while realising all these tasks, is that the machine takes random inputs. It also takes the daily conversation and its very likely that a person mentions "lights" and "off" in the same sentence when one wants the lights to be on. A simple solution to this is putting a keyword into play. The machine gets active only when input is a particular phrase, In this case, the phrase is : "OK Hiko". After hearing "OK" Hiko, it can do whatever speak.

F. *Special User*

This is the most unique feature which seperates hiko from all the automated assistants. A special user in a house is the person who has the access to each and every electric or electronic components in the house. It also has some special features included. A special user can ask: "What is the time?" , "How is the whether outside?". It replies suitably with realtime data extracted from internet.

G. *Webapp Features*

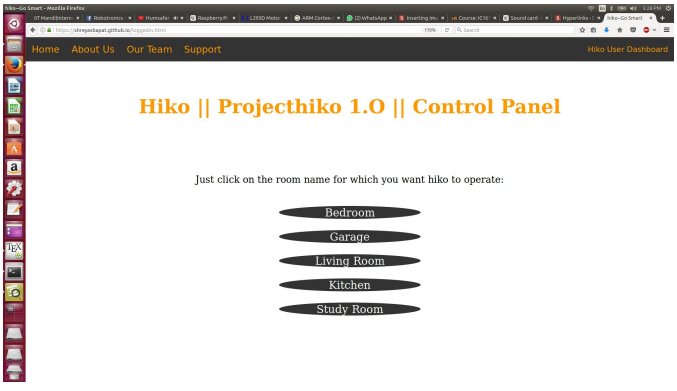


Figure 3. Control Panel of the house. Click on the room for which you want to operate for:

The control panel visible in Figure 3 is for whole house. For a particular operation related to a particular room, one has to click on that button. Then a window would be shown like in Figure 4.

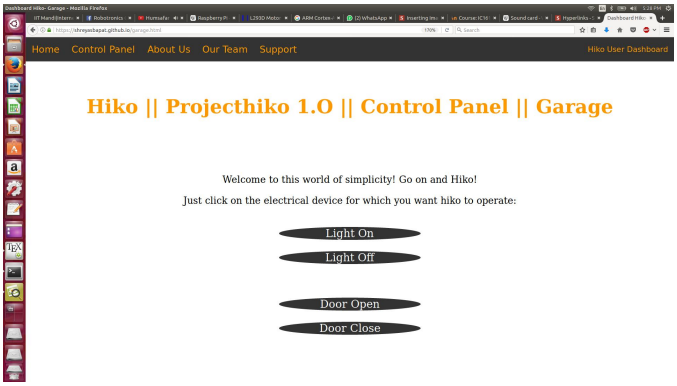
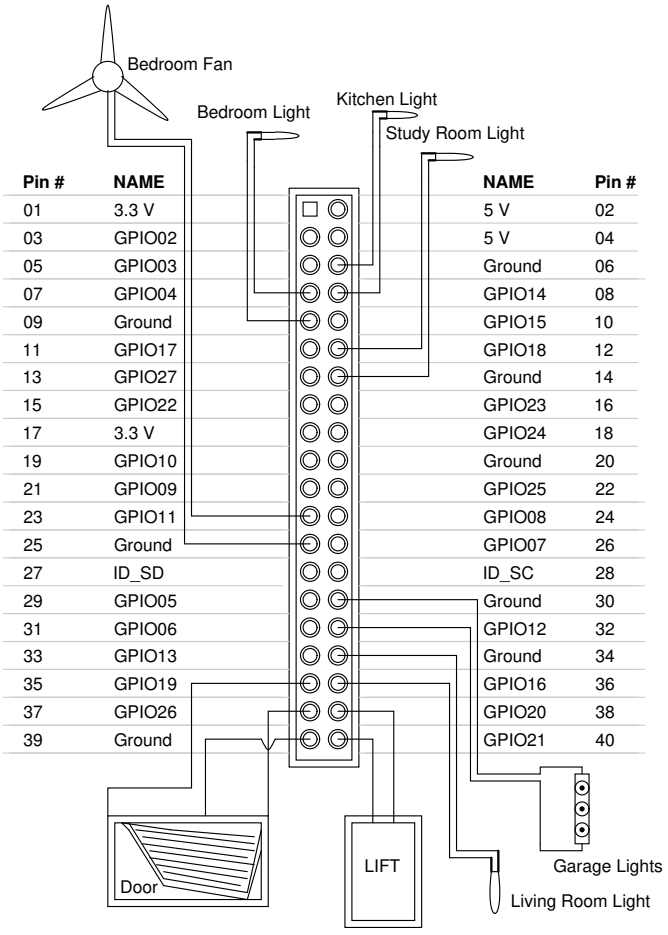


Figure 4. Buttons for the particular operations. The user has to click on desired button to operate.

This is the Control Panel of that particular room. It lists all the components which can be controlled using this webapp and includes the buttons to operate it.

IV. CIRCUIT DIAGRAM AND EXPLAINATION



Pin #	NAME	NAME	Pin #
01	3.3 V	5 V	02
03	GPIO02	5 V	04
05	GPIO03	Ground	06
07	GPIO04	GPIO14	08
09	Ground	GPIO15	10
11	GPIO17	GPIO18	12
13	GPIO27	Ground	14
15	GPIO22	GPIO23	16
17	3.3 V	GPIO24	18
19	GPIO10	Ground	20
21	GPIO09	GPIO25	22
23	GPIO11	GPIO08	24
25	Ground	GPIO07	26
27	ID_SD	ID_SC	28
29	GPIO05	Ground	30
31	GPIO06	GPIO12	32
33	GPIO13	Ground	34
35	GPIO19	GPIO16	36
37	GPIO26	GPIO20	38
39	Ground	GPIO21	40

Figure 5. Circuit of the whole hiko system[3]

The cicuit in Figure 5 is the main circuit of hiko. Shown in the figure are GPIO(General Purpose Input Output) pins. These are connected to Fan, Lights, Lift etc. These pins can act as output or even input pins, analog or digital.

V. PSEUDO CODE

Algorithm 1 Algorithm for Data Interpretation

procedure STRING INPUT ON KEYWORD ACCEPTANCE
    string ← file.txt
    if "$OKHiko$" *in string* **then return** true
    enter to hiko
loop:
    if "$RoomName$" *in string* **then**
    if "$DeviceNameAndState$" *in string* **then**
    $Device \leftarrow State$
    goto *loop*.

VI. RESULT

The voice recognition algorithm works properly and gives correct outputs according to the given voice inputs. The commands given using webapp are correctly recognized by the system and the tasks given are implemented in the desired way.The system works properly on the prototype developed.

VII. CONCLUSION

The automated home is very effective in terms of cost, usability, comfort. It is highly efficient as, on taking extra energy input, it has the capabilities of reducing the energy consumption on a whole. The system is highly interactive and very user friendly which makes a customer buy it. Also, the webapp developed is highly responsive and interactive. The UI is also user friendly. The model only did show a limited usage of what it can do. Say it a lack of money or lack of resources. It has a wide range of applications. Practically, the system can be connected to each and every thing present in the house.

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