

Voice Recognition Based Home Automation System for Paralyzed People

Mukesh Kumar, Shimi S.L

Abstract— This paper presents the design of the low cost voice recognition based home automation system for the physically challenged people suffering from quadriplegia or paraplegia (who cannot move their limbs but can speak and listen) to control the various home appliances and can actuate the bed elevation just by the voice commands according to their need and comfort. The proposed system consists of a voice recognition module, Arduino uno microcontroller, relay circuit to and an adjustable bed. The voice recognition module needs to be trained first before it can be used to recognize commands. Upon successful recognition of voice command the Arduino drives the corresponding load with the help of the relay circuit. The adjustable bed elevation can be set to the three different modes as per the user comfort and need. The accuracy of voice recognition module is also measured in different conditions. The experimental results validate the functions of the proposed system. The results show the system can provide great assistant to the physically challenged people without any third person's assistances.

Index Terms— Home Automation System, Physically Challenged People, Voice Recognition Module V3, Arduino Uno, Adjustable Bed Motorized Jack.

I. INTRODUCTION

The home automation systems are gaining popularity day by day due to their ease of use and wide operations capabilities. Integrating voice recognition technology to home automation systems make the system more user friendly and easy to operate. Some require home automation system to satisfy their needs and comfort while for physically challenged people it can provide great assistance.

There have been several researches and developments on the home automation systems. The voice recognition based home automation system [1] uses the Microsoft speech API running on PC to recognize the voice commands. The RF transceiver is used to send these commands to the controller to control the various electrical devices. The use of computer makes this system more expensive and difficult to handle.

Intelligent home navigation system for disabled and elderly person [2] proposed a system which uses voice recognition module SR-07 for the speech recognition process, an Arduino controller, a wheel chair and a navigation module. The Arduino receives the command from the voice recognition module and move the wheel chair accordingly thus eliminating the need of any third person's assistance.

The voice recognition based home automation system [3] uses Lab VIEW to perform speech recognition and Zigbee module with a controller is used to control the devices wirelessly. The Limitation of the system [1] [3] is the use of the computer which makes system more expensive.

[4] Proposed a home automation system which comprises a DSP processor for the voice recognition function, a microcontroller and relay module for the appliances control function like switching lights on-off etc. Zigbee wireless module is used which eliminates the need of additional wiring required for the signal transmission.

[5] Proposed a home automation system for elderly and physically challenged people which can control the home appliances by two methods by voice commands or by using mobile as remote controller. The voice recognition is done by the android application and thus given to the controller to control the devices.

The home automation system [6] proposed two ways to control home appliances that are by using timer or by using the voice commands. The software environment is developed on Virtual Basics 6.0 on PC and devices are controlled using PC parallel ports.

[7] Proposed a Bluetooth based home automation system which comprises of a remote controller interfaced with microcontroller which is additionally interfaced with the Bluetooth module to provide wireless control of the appliances. When key on the remote controller is pressed the controller sends the command via Bluetooth module to the receiver and corresponding action on the receiver side is taken.

[8] Proposed system which uses PC to convert the voice commands to text and send this converted text to the cellular network via mobile phone, on receiver side the text is received by another mobile phone and this command is read by the microcontroller and corresponding control action is taken.

[9] Proposed a system which can control devices from the large distance. The user voice commands are converted into the symbols and they are sent to server PC over WI-FI network. The PC contains the voice recognition application developed on Microsoft VisualBasic.net. When the given command is recognized this information is transferred to the control circuit through PC parallel port and the corresponding device is turned on or off.

[10] Proposed a voice recognition based automation system for the industry which uses HM2007 voice recognition module for the voice recognition function which provides

maintenance engineer and disabled person in the industry to operate the loads easily and comfortably.

I. SYSTEM OVERVIEW

The voice recognition based home automation system is an integrated system to facilitate the elderly and physically challenged people with an easily operated home automation system that operates fully on voice commands. The functional block diagram of the proposed system is shown in Fig.1.

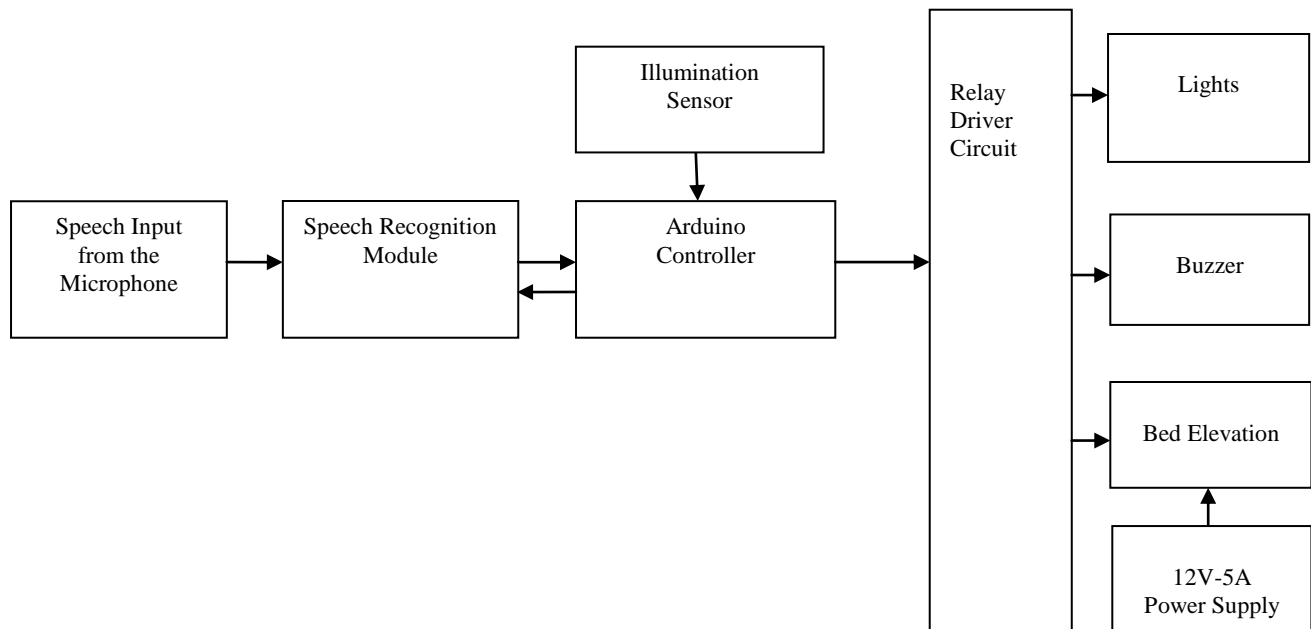


Fig. 1 Block Diagram of Voice Recognition Based Home Automation System

The speech input from microphone is given to the voice recognition module where the speech signal is compared with the previously stored trained voice samples. Upon successful recognition of voice command the Arduino microcontroller actuates the corresponding electrical device like turning on lights, and adjusting bed elevation using the relay module. The data from the illumination sensor is processed in Arduino controller and based on a set point value the automatic control action is taken to switch off the lights to save energy. The buzzer sounds when disabled person need is calling for help or when he needs somebody's assistance.

II. HARDWARE IMPLIMENTATION

The hardware implementation of proposed system shown in Fig.1 is explained in this section.

A. Microphone and Voice Recognition Module

The microphone used to get voice commands to the voice recognition module is a simple collar type microphone with 3.5 mm jack. Elechouse voice recognition module v3 is used for the voice recognition process as shown in Fig.2. The voice recognition module needs to be trained before it can be put to actually recognize the voice commands. The speech input from the microphone is given to the voice recognition module and there the input speech is compared with the previously trained voice commands and if there is a match then control action through control circuit is taken. The voice recognition module v3 can store up to 80 commands of 1500ms each in its

library and out of 80 only 7 commands can be loaded into recognizer for the recognition process. Thus only 7 commands are effective at a time and to add another 7 commands recognizer needs to be cleared first. The module has two ways of controlling Serial Port, General Input Pins. General Output Pins on the board could generate several kinds of waves while corresponding voice command was recognized. Module has a recognition accuracy of 99% under ideal conditions.

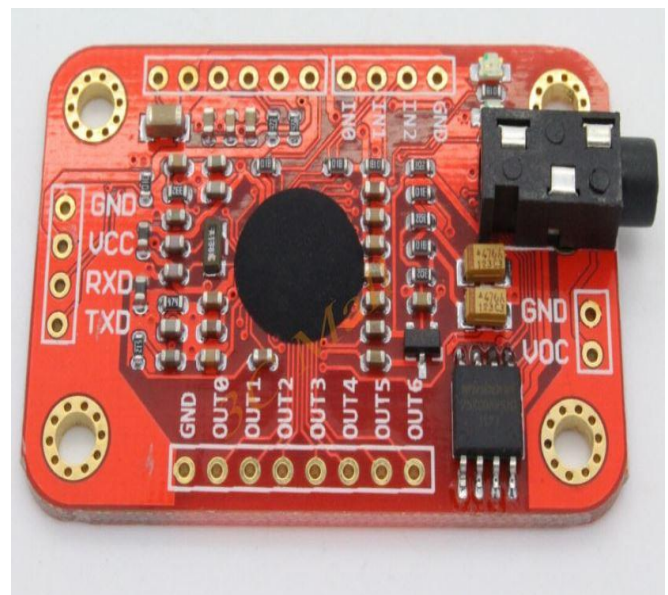


Fig. 2 Voice Recognition Module v3

B. Arduino Uno

The controller used for the proposed system as shown in Fig. 3 is Arduino Uno microcontroller. The Arduino platform provides an inexpensive and easy way for students and professionals to create devices that interact with their environment using sensors and actuators. Arduino comes with simple integrated development environment (IDE) which runs on a PC and allows user to write programs for Arduino in C or C++ language. The Arduino microcontroller is based on the ATmega 328. It has 14 digital input/output pins (Out of these 14 pins 6 can be used as PWM outputs) and 6 analog inputs. Arduino works on 5V D.C and has clock speed of 16 MHz.



Fig. 3 Arduino Uno Microcontroller

C. Light Sensor

Light dependent resistor is used to sense the illumination inside the room so that the system can shutdown the lights when there is sufficient day light to see anything around to conserve energy.

D. Buzzer

Buzzer is main indicators of the designed system through which the guardians of the disabled people can be alerted to check disabled person when buzzer makes a sound and take necessary care. If the patient needs any help then by voice command he or she may turn on the buzzer for help.

E. Relay Circuit

To control the Home appliances relays are used with the Arduino. The relays used in the system are 5V-5 pin relay as shown in Fig. 4. The relay remains in normally closed state. When relay coils are energized the relay switches from normally closed to normally open state due to electromagnetic induction. The normally open state (N.O) of relays is used in the home automation system. Fig. 4 shows the buzzer, illumination sensor and relay on embedded on the general purpose PCB.

F. 12V, 5A Power Supply

All electronic circuits work only with low dc voltage. It needs a power supply unit to provide the appropriate voltage supply.

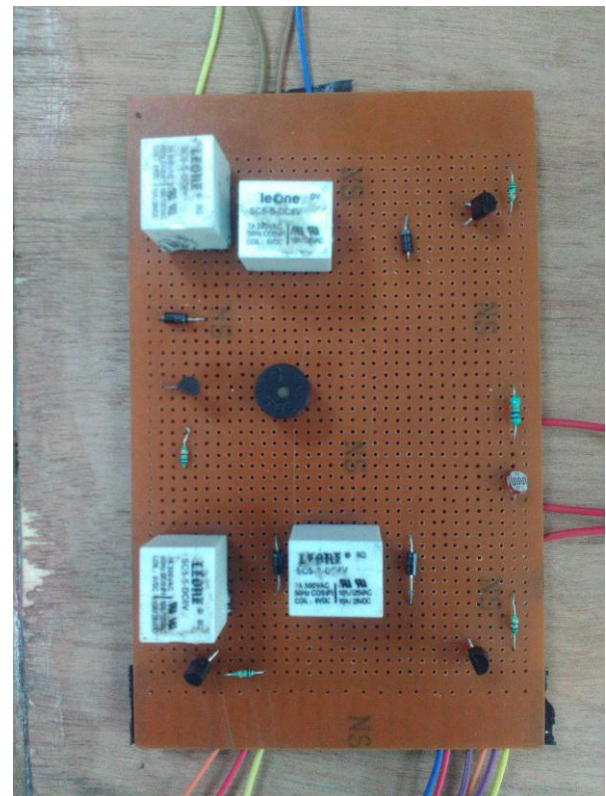


Fig. 4 Relay Circuit, Buzzer and Illumination Sensor

The power supply requirements for the home automation system are 5V for the relay circuit and 12V 5A for the motor of the jack that actuates the bed elevation. The 5V supply requirement can be fulfilled from Arduino board itself but for the 12V 5A supply we need additional supply circuit. A Centre tap transformer of 15-0-15 V is used here. After that a Bridge rectifier circuit is used which converts the A.C to D.C. The D.C after conversion is not ripple free therefore capacitor $C_1 = 3300\mu\text{F}$ and $C_2 = 0.33\mu\text{F}$ are used to get ripple free. To regulate the voltage LM338K Voltage regulator is used which gives a regulated voltage of 12V and constant current of 5A. The capacitor $C_3 = 100\mu\text{F}$ is used to eliminate the ripples from the output voltage and the diode D3 is used to protect the circuit when the capacitor C3 discharges. Fig. 5 shows the circuit diagram of the 12V, 5A power supply and Fig. 6 shows the embedded circuit of power supply on PCB. Fig. 7 shows the complete assembly of the electronic circuit of the voice recognition based home automation system.

G. Buzzer

Buzzer is main indicators of the designed system through which the guardians of the disabled people can be alerted to check disabled person when buzzer makes a sound and take necessary care. If the patient needs any help then by voice command he or she may turn on the buzzer for help.

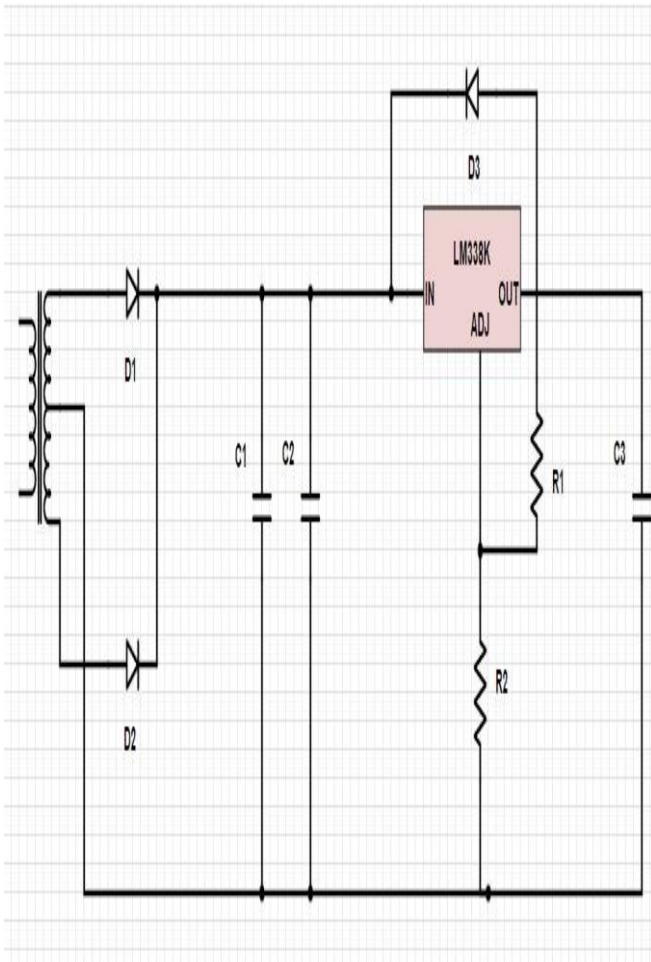


Fig. 5 12V, 5A Power Supply Circuit Diagram

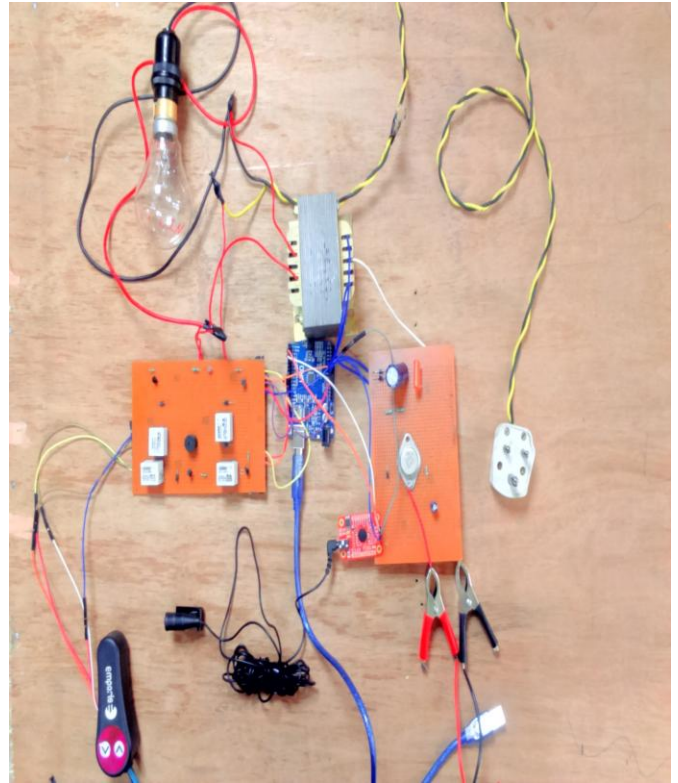


Fig. 7 Complete Assembly of the Electronics Circuit

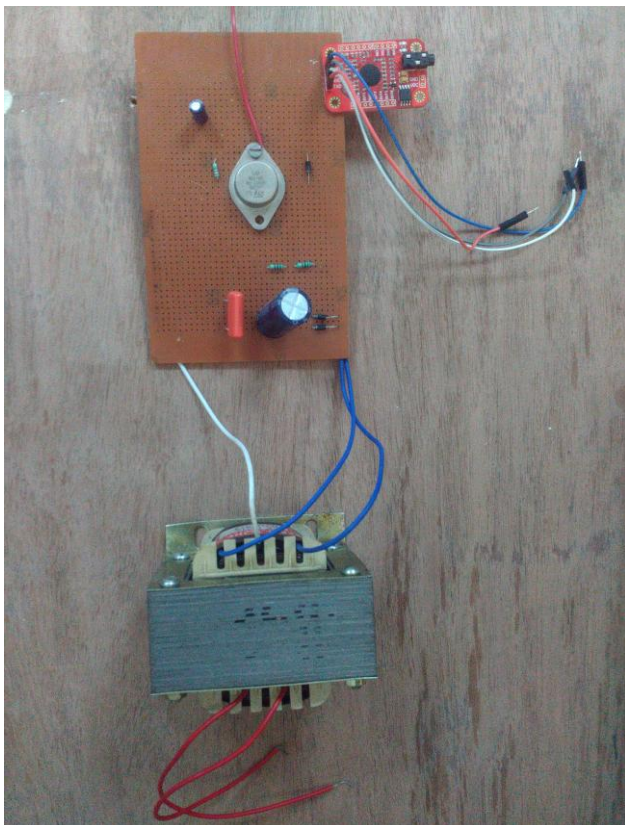


Fig. 6 12V, 5A Power Supply

H. Bed Modelling and Elevation Control Mechanism

The bed for home automation project is used along with a motorized jack. The motorized jack is used to lift up the bed or bring it down. Instead of using a metal chassis as used in commercially available beds here a wooden bed is modelled which uses less time and less money to build. The total length of bed is 6 feet out of which 2.5 feet length is made moveable with the help of connectors and the rest 3.5 feet is kept stationary. The width and height of the bed is 2 feet. Beneath the movable part of bed there is a box type structure on the top of which motorized jack is fixed which will lift the bed moveable part up or down and in the box structure the home automation system electronics is placed as shown in Fig. 8. The Emporis Motorized Jack is operated on 12V dc with 10A maximum current and can lift the weight up to 1500kg. The lifting range of the jack is from 12cm to 35 cm which is equal to 1feet approximately. The jack also has the limit switches which stop the motor when certain height is reached or jack is lowered to a certain point. The jack uses the motor for lifting up the bed and bringing back to ground position and the motor direction is controlled by the relays. The motor used in jack is a 12V dc motor. Fig. 9 shows the working of adjustable bed with a person lying on it.

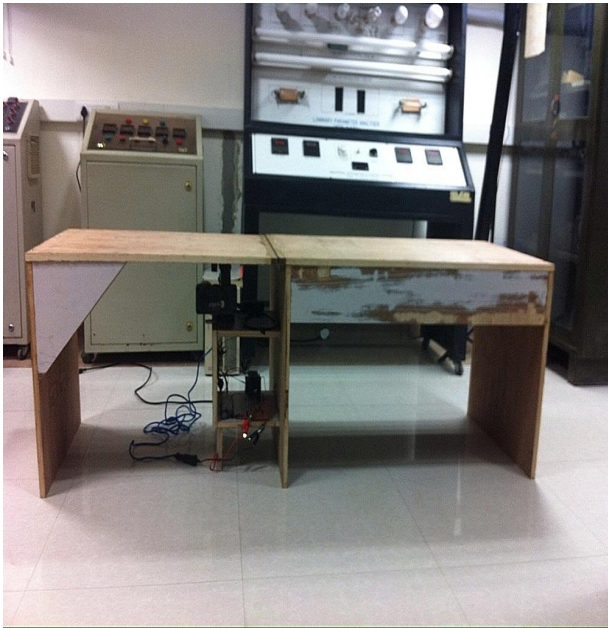


Fig. 8 Adjustable Bed



Fig. 9 Bed Elevation with the Person Sleeping on the Bed

III. SOFTWARE IMPLEMENTATION

The software implementation part of voice recognition based home automation system implemented using the Arduino controller. It consists of training of voice recognition module. The voice recognition module needs to be trained first with the voice commands before it can be put to recognizing function. The voice recognition module training program is loaded into the Arduino and then trained with the voice commands. Fig. 10 shows the training process of voice recognition module using the Arduino IDE. The main code for the home automation system is written in C++ language in Arduino IDE. Upon successful recognition of voice command the control action corresponding to that command is taken.

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COM8
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Elechouse Voice Recognition VU Module "train" sample.
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Usage:
-----
COMMAND      FUNCTION      EXAMPLE      Comment
-----
train        train (x1) (x2) ...  train 0 2 45      Train records
load         load (x1) (x2) ...  load 0 31 2 3     Load records
clear        clear           clear           remove all records in Recognizer
record       record / record (x1) (x2) ...  record / record 0 79  Check record train status
vr           vr              vr              Check recognizer status
getsig       getsig (x)       getsig 0         Get signature of record (x)
sigtrain     sigtrain (x) (sig)  sigtrain 0 3200   Train one record(x) with signature(sig)
settings     settings         settings         Check current system settings
help        help            help            print this message
-----
sigtrain 0 waitmp

Record: 0   Speak now
Record: 0   Speak again
Record: 0   Cam't matched
Record: 0   Speak now
Record: 0   Speak again
Record: 0   Cam't matched
Record: 0   Speak now
Record: 0   Speak again
Record: 0   Success
Success: 1
Record 0   Trained
STD: waitmp

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Fig 10 Voice Recognition Module Training using Arduino

IV. RESULTS AND DISCUSSIONS

The main objective of this project is to design a voice recognition based home automation system for controlling appliances and model a adjustable bed which can adjust the elevation according to the voice commands given by the user. The recognized voice command makes Arduino to switch the relay and change the direction of motor due to which jack lifts the bed up or bring back bed to lower elevation angle, turn on off the lights and sound the buzzer when disabled person need help. The Illumination sensor turns off the lights automatically when natural light is sufficient to see around. The adjustable bed offers three elevation positions sleep position, rest position and sitting position. The sleeping position is the position where bed is at 180 degree elevation to the ground as shown in Fig. 11. The person can sleep comfortably in this position. In the rest position the bed is elevated at 150 degree to the ground and a person can comfortably relax in this position as shown in Fig. 12. In the sitting position bed elevation is almost equal to 135 degree and nearly the person is in sitting state as shown in the Fig. 13. Table 1 shows the current drawn by the motor when lifting the bed up or lowering down at different weights. The Fig.14 represents the comparison graph between the current drawn by the motor at different weights. The comparison graph shows that the motor draws more current when higher weights are lifted by the jack but lowering the bed down the current drawn by the motor almost remains constant. The no load current of the motor is 1.050 Amperes when jack is opening and when jack is closing the current is 0.710 Amperes. Table 2 shows the list of commands and the functions performed by each command.



Fig. 11 Bed Elevation in Sleeping Mode



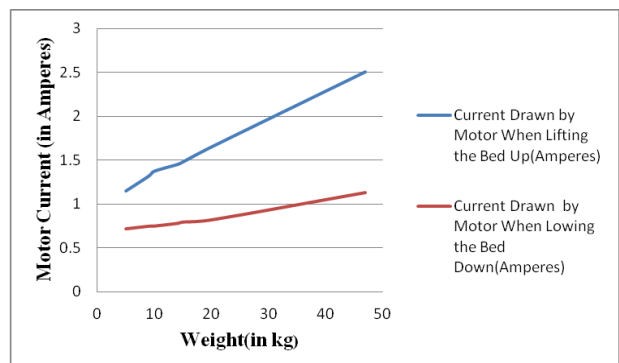
Fig. 12 Bed Elevation in Rest Mode



Fig. 13 Bed Elevation in Sitting Mode

TABLE 1
 CURRENT DRAWN BY THE MOTOR WHILE LIFTING BED UP OR LOWERING DOWN AT DIFFERENT WEIGHTS

Sr. No.	Weight(Kilo Grams)	Current Drawn by Motor When Lifting the Bed Up(Amperes)	Current Drawn by Motor When Lowing the Bed Down(Amperes)
1	5	1.150	0.718
2	9	1.319	0.748
3	10	1.375	0.750
4	14	1.451	0.780
5	15	1.480	0.795
6	20	1.650	0.820
7	47	2.503	1.130



Sr. No.	Voice commands	Experimental Trials					Total Responses
		1	2	3	4	5	
1	On	1	1	1	1	1	5
21	Control	1	1	1	1	1	5
2	Control	1	1	1	1	1	5
3	Off	1	1	1	1	1	5
3	Off	1	1	1	1	1	5
4	lights	0	1	1	1	1	4
4	lights	0	1	1	1	1	4
5	Dark	1	1	1	1	1	5
5	Dark	1	1	1	1	1	5
6	Bed	0	1	1	1	1	4
7	Sleep	1	1	1	1	1	5
8	Rest	1	0	1	1	1	4
8	Rest	1	0	1	1	1	4
9	Up	1	1	1	1	1	5
9	Up	1	1	1	1	1	5

Fig.14 Current Drawn by the Motor While Lifting Bed Up or Lowering Down at Different Weights

TABLE 2
VOICE COMMANDS AND THEIR FUNCTIONS

Table 3 and Table 4 show the test results of the trails performed on the voice recognition module to determine the accuracy in the silent condition and in noisy condition. Total five trials are carried out for each command listed in the table. Out of five trials speech recognition module recognize the voice command correctly. The percentage of accuracy of voice recognition module under the silent condition is 80%.

TABLE 3 RESULTS IN SILENT CONDITION

TABLE 4 RESULTS IN NOISY CONDITION

Sr. No.	Voice commands	Experimental Trials					Total Responses
		1	2	3	4	5	
1	On	1	0	1	1	1	4
2	Control	0	1	0	0	1	2
3	Off	1	0	0	1	1	3
4	lights	0	1	0	1	1	3
5	Dark	1	0	1	0	1	3
6	Bed	0	1	0	1	0	2

7	Sleep	0	1	0	1	1	3
8	Rest	0	1	0	1	1	3
9	Up	1	1	0	1	0	3

Under the noisy condition out of five trials only three were correctly recognized thus the accuracy of the voice recognition module under noisy condition is 60%.

V. CONCLUSION

The voice recognition based home automation system was built and implemented. The system is specially designed for the people suffering from paralysis and also for the elderly people. A wooden adjustable bed fitted with motorized jack is modelled rather than building a mechanical base with linear actuators which is proven to be very economic. The adjustable bed offers three elevation positions sleep position, rest position and sitting position and according to one's comfort he or she may choose position by voice commands. The use of voice commands eliminates the need to remote controllers and other electronic device and makes it easy to interact with the system to perform automation and control electrical devices. Buzzer allows disabled person to notify the guardians whenever the person need help. The illumination sensor automatically turns off the lights when sun light is enough to see things around also a time delay is added that if user forgot to turn off lights or any device the will be automatically turned off to conserve energy.

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