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Smart Vertical Lift for Disabled Person

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Abstract

This paper proposes the voice command operated design of vertical lift for differently challenged people, suitable for three out of four Disability categories, for elderly, physically challenged, visually impaired, auditory impaired, and people with some degree of motor inability. The Preliminary design is the result of the study of an actual site, understanding the requirements of four major disability types, their ergonomics, available assistive devices, and literature review. In addition, other factors like the disability act, user equipment regulations, user safety, emergencies, and operational requirements of lift were studied. The first part of this paper is the mechanical design, actuation design with the capacity to lift one "wheel-chaired" person (or any differently challenged person) along with an assistant in case available. Scissor-type electro-hydraulic actuated design takes care of 500 kg., Safe load for 02-meter lifting height, supported by FEA results. For Voice command operation experiments, used ATmega328P microcontroller, SPCE061A Sound controller, APR33A3, USB-TTL, HC-SR04 ultrasonic distance sensor, and LCD. Used "Access port" and "HTerm" software. Recorded and tested 05 commands to drive the test motor & LED signals for defined logic. The paper includes a block diagram and flow diagram of lift Operation. This paper details the experiments for voice recording & playback, voice recognition using SPCE061A, the software for voice commands input, and usable format conversion and testing of 05 commands to operate the motor. The paper consists of hardware information, methods, and connections of hardware used during the experiments, step-by-step processes, and cases of logic, failure and success of the techniques before the final results.

Keywords
Differently Challenged Person 1, Specially Able Person 2 and Voice Command Operated lift 3.

1. Introduction

As per WHO 2011 report, 1 billion out of 7.87 billion population in the world are (one or other way) disabled. Out of the 70 million total world population, 12.7% have disabilities of varied nature, 3.2% have a visual disability, 6% have auditory, 2.6% people have an intellectual disability, and 1 % have a physical disability.2.2% of the Indian population has some form of disability as per the census 2011. Other than the elderly, there are people with temporary or permanent disability types, like locomotors disability, leprosy cured person, cerebral palsy, dwarfism, and chronic neurological conditions such as Parkinson's disease and multiple sclerosis. There are 1.2 lack wheelchair users in India as per financial express, dated 06th August 2012, and are growing by 10% every 03 years. This world requires easy accessible and safe equipment or facilities for residential buildings, old age homes, hospitals, malls, theatres, bus stands, train stations, airports, and commercial buildings. UN survey 2005 conducted across 114 countries found policies on accessibility, but 37 countries were without progress. And from these countries, 54% did not follow accessibility standards for outdoor environments, 43% did not have public buildings, and 44% did not have schools, health facilities & other public service buildings. The awareness and the government regulations in India found a place only after the "Accessible India Campaign" launched on 3rd December 2015. The Accessibility features like standard ramps, non-slippery walkways, signage, disabled-friendly toilets, helpdesks, and lifts with Braille & auditory information systems are presently well described. Laws and Regulations for Persons with Disability are available now. "The Rights of Persons with Disabilities Act, 2016 (41. Access to transport) and Access Audits of Public Buildings & Places recommended in India since 2015. UNE EN 81-41:2011 is a European Standards for Safety rule for the construction and installation of lifts, Special lifts for the movement of persons and goods. ASME A17 and A18 references are applicable for installations in the United States & CSA B-44, and B355 references are applicable for installations in Canada. ADA compliance is a US civil law for the disabled. It is the "Americans with Disabilities Act" for Accessible Design. This means all electronic, IT, and Products must be accessible to those with disabilities.

1.1 Problem Statement

There are already Lifts or elevators specially designed and used for general people and used at residential and commercial buildings and offices, for Goods and luggage, for Hospital statures, etc. Although, they are not always accomodable, suitable, accessible, controllable, and safe for all kinds of disabled persons who exist in this world without human assistance. Special Lift for wheel chaired person, for people with medical conditions, for those with visibility issues, Audible issues, or motor disability is considered in this paper. Lift design can meet the semi or without-assistance operation ability criteria using the latest technologies and safety logic. From 12.7% of the total disabled persons, the Voice command operated design can fulfill the 10% of the type of disabled persons. It can help about 97% of the world population who can access this kind of lift and system independently. 2.6 % have an intellectual disability ignored here.

1.2 Objectives

To study the requirements of 04 categories of disabilities, focusing on mobility solutions for differently challenged persons using assistive technologies, adhering to the laws, regulations & certification required for the lift for the disabled. To design & develop a voice command operated vertical lift for differently challenged people.

2. Literature Review

For Literature Review considered the research papers, journals which includes facility or technology used for differently challenged person for mobility, movement assistance, for wheel chaired or disabled person or patient. Also Voice command operated elevator and related technology and method if used for operating such type of applications. Navya et al. (2018) research proposes the Smart Stair Lift for Disabled where number of floors is no constrain, one can get along with helper or relatives & other peoples on stair case, it is low cost compare to elevator with civil installation & maintenance cost, this is IOT based Design, has Separately fitted mobile chair and can carry person with wheelchair as well, Can be mounted as per convenience and disassembled easily with little effort, Operates after sensing weight on chair. It is kind of motorized stair lift, stair railings are the basic guide to movement using a seat capable of carrying a dependable person. Manual operation is not available. Only one person at a time forward or reverse can use. During emergency, evacuation can be difficult. Requires having a battery backup. This system can be implemented on straight stairs only, not on curvy Stairs. Johanne L Mattie et al. (2015) proposes an integrated staircase lifts for home access. This is conventional looking stair case, each end can operate as a platform lift, A person in a wheelchair or otherwise can enter either the top or bottom staircase plat form, thus there is never a need to 'call' or wait for the Platform, Option for either use of stairs or a lift, Ready for use on either level, Potential aesthetic advantages when integrating the device into an existing home, descent during a power outage, Self-powered versions are there. This is quite interesting study and invention, good for the grounded independent homes, bungalows, villas, hospital and outdoor entries etc. Not for multi-storied buildings, residential complex. It uses electro hydraulics, mostly a home access solution for a meter height entrance door.

Victorovna et al. (2017) proposes the automation of electromechanical lift for disabled people with mobile control. It is about control system of the lift on the basis of technologies of z-wave and open remote. The lift with mobile control has cradles to move the person in wheelchair for lifting height up to 3 meters with 300 kg maximum load. It is a mathematical model, No prototype shown, proposal cannot be assured without specially arranged location or a platform. Daizo Takaoka et al. (1996) proposed a transfer supporting equipment-applying power assist control basically for lifting the sick and disabled (in resting condition) from beds, and transporting them to other places in the hospitals and the welfare institutes. The equipment helps lift a bedridden person by inserting and extracting plates between the body and bed. This can be mostly helpful for hospital use. Transfer table system is mobile inside the hospital facility and can handle one patient at a time. Syed Faiz Ahmed et al. (2018) proposed the mobility assistance robot for disabled persons using Electromyography (EMG) Sensor. This is a kind of Mobility Assistance Robot (MAR), standing platform with electronic walker. A platform for disabled person to ride on it and move with a max. Speed of 10 km/h. c. Helps pull up a human through its pneumatic system. Helps a wheelchair bound 28 person to stand, navigate and move on wheels (User bind or tie themselves into a standing position without any difficulty) automatically. Controlled by an android mobile phone and Or through Electromyography (muscle movement). Electromyography is method of monitoring the motion of neutrons, converted into analogue electrical signals, further working through these signals. The robotic vehicle has ability to be moved in any desired direction using android mobile application & muscle movement as well. This is very expensive mobility device which needs to be personally owned, allows patients with walking disabilities to take part in outdoor activities, meeting friends, dinning out & maintain their independent lifestyle, public use token based model can work in lavish outdoor facilities.

Vijayan (2014), introduces the implementation and analysis of speech recognition system using ARM 7 Processor. The MFCC and VQ algorithm in MATLAB 7.7, control circuitry in Kiel µVision3 and supporting hardware setup diagram is discussed. Mel Frequency Wrapping technology is used, analysis of result good.Gatane et al. (2016) proposes a frame work, method, block diagram for speech recognition system using microcontroller, MAT lab software to be used for the elevator. No Technical details of elevator capacity, parameters of Motor, Drive. Result does not satisfy the proposed work in this research. Thomas Mohan et.al (2018) presents the block diagram of design of database creation and Training of voice commands, MFCC from database is compared with previously created MAT lab database.

Mobility solution provided to the Wheel chaired person, Hospital patients for bed change or transfer from chair to bed and vice versa. There is Mobile assisted robot for wheelchair, Mechanized chair, Android mobile controlled chair or equipment's. Research papers are found explaining the system or block diagram for speech recognition system using ARM 7 Processor, Mel frequency wrapping technology, using Mat lab software and combination of microcontrollers. But here the complete Lift system was missing including the Design of various elements for it.

3. Design

3.1 Design requirements

3.1.1 Space, clearance and reach requirement for wheelchair inside lift

From IS4963.1987 document, refer Figure 1. The min. clear floor space for Wheelchair user is 48" X 30" (1220 X 762 mm), the reach of the wheel chaired user above the floor to keep switches or push button or gripping handle access points are as follows. The average unilateral vertical reach is 1500 mm (Range from 1350 to 1600 mm), The average horizontal working reach is 775 mm (Range from 715 to 830 mm) ,The bilateral horizontal reach, both arms extended to reach side shoulder high, ranges from 1350 to 1770 mm and averages 1560 mm, An individual reaching diagonally on the wall 1200 mm from the floor. The wheelchair Ramp Height Ratio of 1:12 to 1:20 slope and Angle of slope not more than 17 Degree.

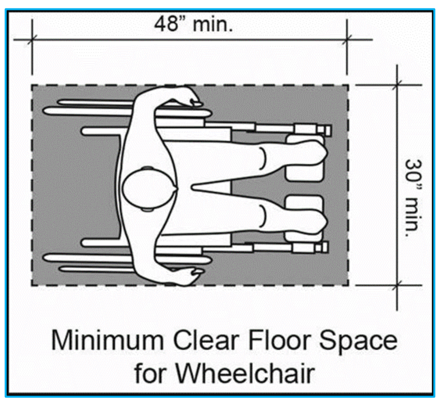

Figure 1. Floor Space clearnace for wheelchair (IS4963.1987)

3.2 Mechanical Design of Scissor Type Electro Hydraulic Lift

Below are the Parameters to suit the requirements. 3D Model created using Creo software. (Refer Figure 2)
The Platform size Required for Wheel Chair = (L X W) = (1200 X 1200 mm)
Construction Type: Scissor Type Electro Hydraulic Lift, Double scissors on both sides.
Connection of the scissors by pins and segments.
Straight Through Entry/Exit: Front-Rear Openings.
Lifting or Working Height: 2 Meter (See Figure 3)
Lift Closing Height: 0.3 Meter (See Figure 4), Speed: @ 35 mm/Sec
Required Lifting Weight: One wheel chaired Person + 1 (200 Kg. Max.)
Design for Safety Weight: 500 Kg. Max. (FOS 1.5* Load)
Scissor profile: Hollow Rectangular 80×40×5 mm, Material:A36 Steel; Yield strength 36,000 psi (250 MPa),
Ultimate tensile strength: 58,000–80,000 psi (400–550 MPa).

Designed size of cylindrical Pins: Ø40 x 120 mm. Matl.: EN E295/EN 1.0050
The opening and closing of the system by wheels moving on the rails.

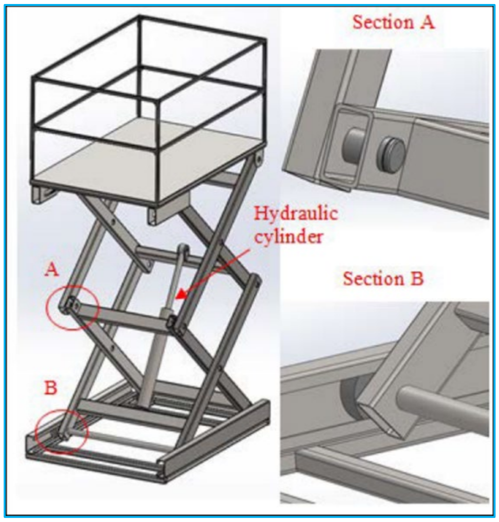

Figure 1. 3D Model of Assembly of Vertical Lift

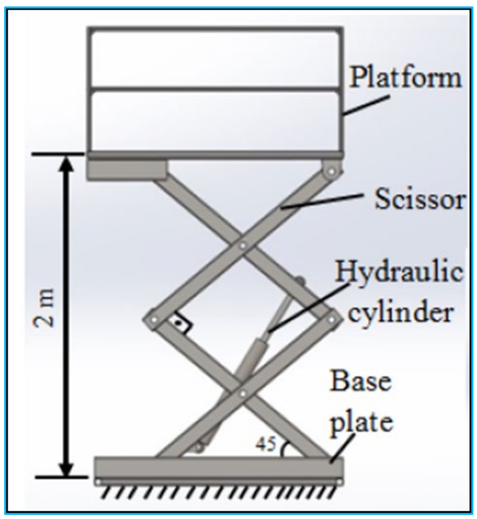

Figure 2. Total Lifting Height of Vertical Lift

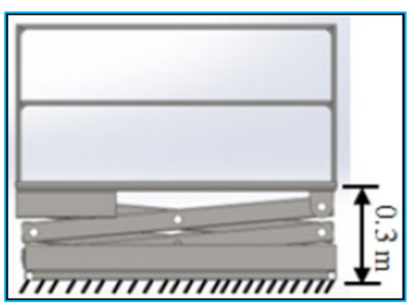

Figure 3. Closing Height of Vertical Lift

Doors and Gates are self-closing delayed type, Door Height is Flush mount 2032 mm, Gate Height is 1070 mm.

Platform cabin is Aluminium with tempered glass enclosure. Door Construction is from aaluminium frame with Panels of 1.5 mm painted GI plate, 5 mm clear Plexiglas with 1.5 mm GI Plate, 5 mm bronze Plexiglas with 1.5 mm GI Plate, 6 mm laminated safety glass with 1.5 mm GI Plate. D-Handle Pull type 12 inch (305 mm) offset D-Handle. Base Mounting & Access to Lift at Lower Landing using Ramp 1:20. Base of lift mounted on the floor surface of the lower landing with ramp. GI Sheet with slip resistant surface, level floor or Slop.

3.3 Actuation Design of Scissor Type Electro Hydraulic Lift

3.3.1 Calculation of Piston Force, Pump Pressure & Piston Diameter

Scissors Position: Fully closed position: 5 °, fully open position: 45 °
The maximum value of Piston Force was obtained at first opening F= 45000 N.
Pressure of pump = 116 bar (11.6 N/mm ^{2}) to produce this piston force (F = 45000 N)
The Piston Diameter of hydraulic cylinder was determined = 70mm.
Area =Force/Pressure = 45000 /11.6 = 3879.31mm^2, So, Piston Dia. D=70.28mm ≅ 70mm

3.3.2 Calculation of Electric motor Power Selection to drive Hydraulic pump

Volumetric flow rate (Q): $Q= LA/t=L\pi d^2/ (4t)$
Stroke of cylinder (L=320mm),
Diameter of hydraulic cylinder (d=70mm),
Lifting time (t=15s)
The volumetric flow rate (Q) = 82100.288 mm^3/s = 0.295m^3/h.
Considering hydraulic efficiency of motor (ηh=0.75),
Pump pressure (P≅11600 kPa),
Motor power (N) =QP/ (3600ηh) = 1.26kW ≅ 1.5kW. = 2 HP

3.4 Hydraulics design and circuit design for lift

Hydraulic Cylinder is DA Ø70 mm X 400 mm stroke, Hydraulic Gear pump (116 bar).
Hydraulic Oil Tank: @ 50 Liter capacity, Hydraulic circuit of scissor lifting system created with the help of Fluid-Sim software, The Hydraulic Circuit & Components are Pressure unit (1), Oil filter(2),Pressure Sequencing valve (3), 4 way three position DCV(4), Bidirectional flow control valve (5), Double acting hydraulic cylinder (6), Hyd. Accumulator (7) (Figure 4).

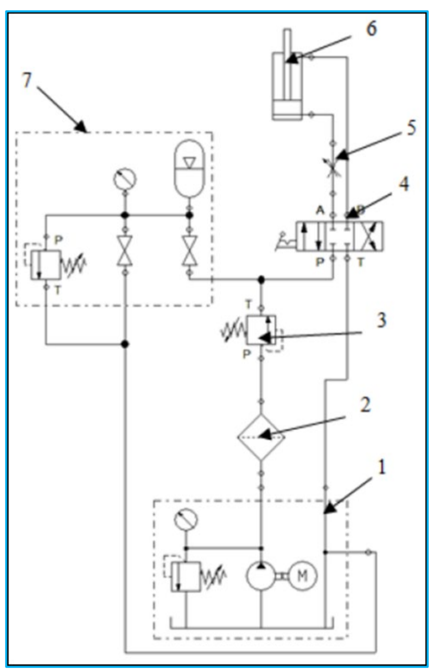

Figure 4. Hydraulic Circuit showing component Arrangment

The calculations are stable for 500Kg lifting load, speed of cylinder at 18mm per seconds, extending force drives at 12272N and minimum Bore diameter is selected as 25mm, Rod Diameter as 14mm for experiments at angular cylinder position.

3.5 FEA Analysis of lift structure

Ansys Software is used to analyse the Lift system structurally, Criteria of result acceptance considered is mmaximum stress should be 50 % of the UTS of Material. UTS of A36 Steel Material: For Scissor Profiles (400–550 MPa). In the 3D model before analysis Top and Base structure are suppressed to ease the simulation. 04 Base positions (Points 1) Fixed at an angle of 45°.Rest of 04 Top positions (Points 2) loaded with 6000N each. Connection points 3 of the piston applied with total load on the cylinder considered as @ 24000N to keep the steady state. Stress distribution, the deformation delta determined according to the maximum strain energy hypothesis (von-Mises) (Figure 5).

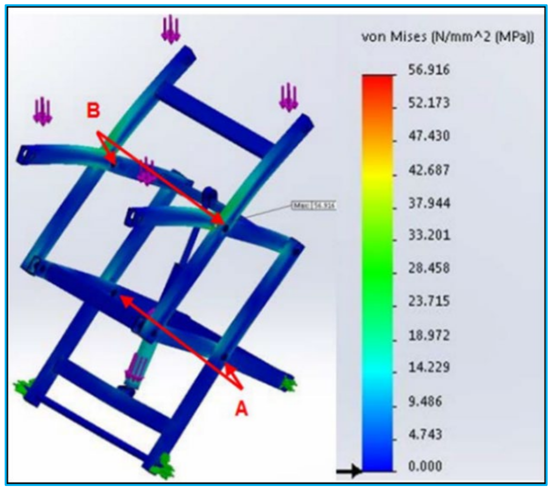

Figure 5. Stress Analysis Result

3.5.1 FEA Result

The max. Stress on the system is @57 Mpa, observed at the Top scissor joints, refer Figure 6. Lower stress on the lower scissor joint found. This is within the acceptable limit of 50% of Material UTS. The maximum deformation of 0.7mm at Top joints refer Figure 7, is much lesser and is observed at Base Joints and meets Acceptable criteria. The system design is safe to use for vertical lifting for Max. 500 Kg Capacity for lifting height of 2 meters. (The Safety Factor is ratio of yield stress to the max. Stress of part). The lowest safety coefficient is 4.3 at the scissors joints of A36 Material; the safety factor of the pins is 6.2. Design is safe since the minimum safety factor must be 3 or more for lifting systems (Figure 6).

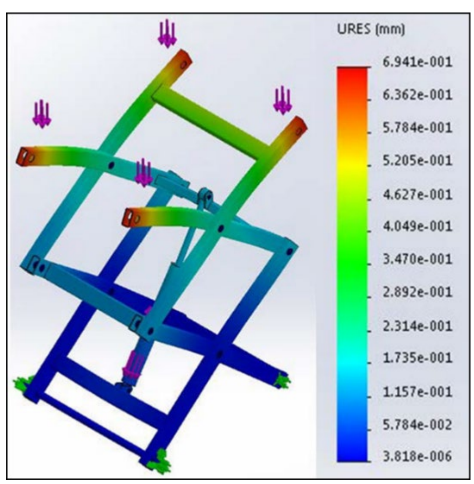

Figure 6. Analysis Result showing maximum deformation

3.6 Operation Flow Diagram

The Basic Logic Diagram, refer Figure 7 and Figure 8, is determined to clarify the commands with respect to lift position at ground or first floor in terms of 0,1. This also helps the interconnecting positions, respective positions of lift, its Cylinder Positions, Electronic hardware ON-OFF, Sensor Switch ON-OFF, Gate & Door Positions during the active command of ground or first Floor. The Operation Logic is to identify & showcase the sequence of each of operation right from Start to System Reset, Wheelchair or person/s movement detection, the respective command of destination, the Emergency situation etc. This also helps to connect the Mechatronics circuit with hardware to the Main lines according to the operations requirement. This will be displayed inside the lift for all users, another copy will be a part of User operation Manual and useful for regulations and lift Audit. While system is ON and START initiated, it determines the overall status of initial parameters, positions & resets them to original. Detects the Wheelchair or Movement of personal, Opens the Entry Half Door, Lift Gates, Platform Wait sensors recognizes the Persons wait, alarms if more or and proceeds further, waits for the Input Command by one of the means like Voice, Touch Pad, Foot Pad or Eye Movement. Lift moves to the destination position (Ground or First), After reaching Gates Opens waits for the Person Load to get off load with Delay time for wheelchair, Gate closes, Exit Door opens due to Proximity Sensor and with Delay Disable person moves on, Lift System Resets waits for the next command at both upper and lower positions. During Emergency or Power Off in the middle of reaching the lift position it automatically rests at the nearest Position and in the direction of Lifts initial movement. The Hydraulic System along with the Gates, Doors, and Sensors operates in conjunction with respect to each other as shown in the Flow Diagram.

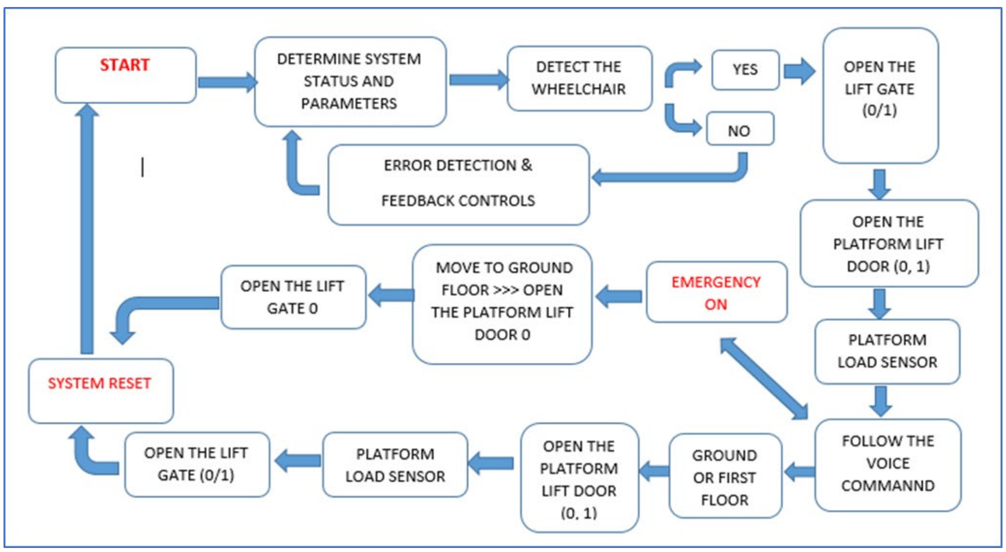

Figure 7. Operation Flow Diagram

3.7 Hardware, Software and Operation of the Smart Lift using Voice Command

3.7.1 Experiment 1: Identify & Test the Hardware for Testing of Obstacle Sensor

A Program code is written and Tested & Hardware setup to test the HC-SR04 Sensor, LCD Display to show the distance while Buzzer activates at 1 Feet as Safety Distance from the Door to sense the Wheelchair or User movement. Hardware used is ATmega328P (RISC based Microcontroller), Ultrasonic Sensor: HC-SR04, LCD Display ATmega328P is the Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general-purpose I/O lines, 32 general-purpose working registers, 3 flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8 channels in TQFP and QFN/MLF packages). HC-SR04 is chosen since it is economical sensor. This Sensor provides the range of 2cm to 400cm of non-contact measurement functionality, with very good accuracy up to 3mm. HC-SR04 module includes an Ultrasonic transmitter, a receiver along with a control circuit. Range is 40 to 70 kHz, Sensing range at 58 kHz, Measurement Resolution is 01 centimetre (cm), and Max. Range is up to 11 meters.

The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo, The Ground and the VCC pins of the module connected to the Ground and the 5 volts pins to supply source, the trig and echo pins connected to Digital I/O pin on board. The HC-SR04 sensor VCC to the +5V, sensor GND to the GND, sensor Trig to the Digital 9, sensor Echo to the Digital 10. LCD Display VSS to GND, LCD VDD to +5V, LCD VO pin to 10k Potentiometer centre pin, LCD RS pin to digital pin 1, LCD RW pin to GND, LCD Enable pin to digital pin 2, LCD D4 pin to digital pin 4, LCD D5 pin to digital pin 5, LCD D6 pin to digital pin 6 & D7 pin to digital pin 7.

3.7.2 Experiment 2: Identify & Test the Hardware for Voice recording and play back.

This is to record the Message and Playback as per the Logic of system. Hardware used is APR33A3 a Voice Recognition Module which has speaker: 8 Ohm & 0.5 Watt. The APR33A series is a powerful audio processor along with high-performance audio analog-to-digital converters (ADCs) and digital-to-analog converters (DACs). APR33A has operating voltage range of 3v ~ 6.5v is a single chip, high quality audio/voice recording & playback solution, no external IC required , has 170/ 340/ 680 sec. voice recording length, powerful 16-bits digital audio processor. has built-in audio-recording microphone amplifier, differential-ended mic pre-amp for low noise high quality line receiver, high quality analog to digital, DAC and PWM module resolution up to 16-bits .m1 to m8 channel, averagely 1, 2, 4 or 8 voice messages & 1.3 minutes recording length for each.

Power switch slide to + 5v supply (option + 12v), onboard mic is used for recording, switched on the board power led (ld1) is on, used the slide button called rec/play, selected the recording mode, while in record mode, used M1 channel for audio recording of "Welcome", M2 for "WELCOME to the Ground Floor and M3 for "Welcome to the First Floor" and recorded the message for recording in channel M1, pressed & hold the M1 button, same for M2 and M3. MIC captured the Voice Message and it is got recorded, status LED (LD2) was ON in record mode, LED (LD2) got off after that segment was used and full. Released the M# button to stop recording.

3.7.3 Experiment 3: Identify & Test the Hardware for Voice Recognition, Software for same and Testing of Commands to operate the Motor

This is executed to write a code, setup the hardware and test the Voice Recognition Module (SPCE061A Sound controller), Red, Green and Yellow LED signals to identify with the Servo Positions of Ground (90 Degree) and First (180 Degree). Hardware used is SPCE061A Sound controller, USB-TTL (CP2102-USB to UART Bridge), Standard flexible wire micro phone, software tested and used Access Port & HTerm.

Voice recognition module working voltage is 4.5-5.5v, Current < 40mA, Digital Interface is 5V TTL level UART interface. Analog interface is 3.5mm mono-channel Microphone connector with microphone pin interface. This can store 15 voice instructions in 3 different Groups. Installed Drivers for USB-TTL (CP2102-USB to UART Bridge), Voice Recognition module connected to USB-TTL to connect GND to GND, RXD to TXD, TXD to RXD, VCC to +5V. Loaded "Access Port" software as part of first experiment to record the voice command in "Hex" format, Set the Baud rate to "9600 "in "Configuration" ,Set the "Hex" and "Char "in Send and Receive display respectively(Figure 8).

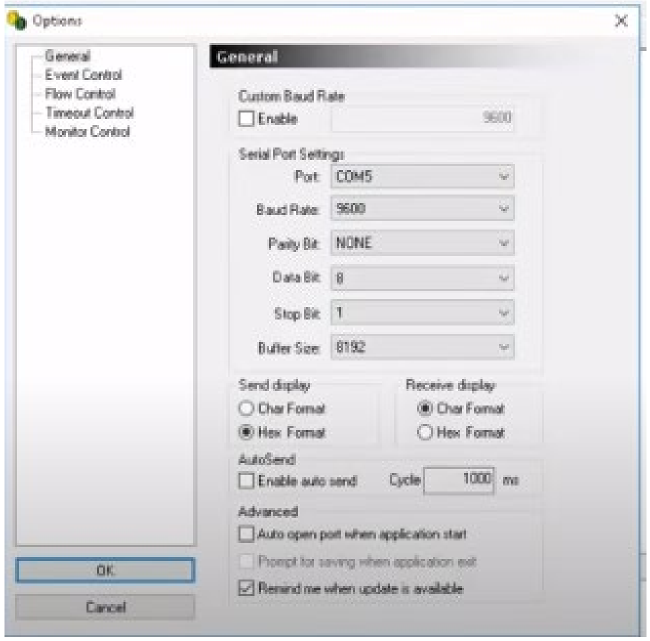

Figure 8. Access Port Software Setup

Used AA 36 command to set Common Mode, AA 11 to Record the commands, AA 21 to “finish” the Group. Recorded 05 commands in Group 1 as “GREEN”, “RED”, “YELLOW”, “GROUND” and “FIRST”, 05 sample Commands are now saved to the Module and ready to use for the final application.

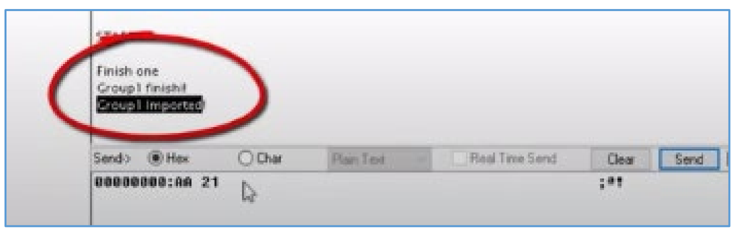

Figure 9. Recording of 05 commands in Access Port Finished

Method and Connections for Part 1 B using HTerm: Drivers installed for USB-TTL, Voice Recognition module connected with USB-TTL, GND connected to GND, RXD to TXD, TXD to RXD & VCC to +5V respectively. Loaded “HTerm” software to record the voice command in “ASCII” format standard and decodes to “Hex” format. Set the Baud rate to “9600 “in “Configuration” , Set the “ASCII” and “Hex” in Send and Receive display respectively. Other options are “Decimal”. “Binary”, “Octal”, “CMD” formats. Used AA 36 command to set Common Mode, AA 11 to Record the commands, AA 21 to “finish” the Group. Recorded 05 commands of max 1300ms length each in Group 1 as “GREEN”, “RED”, “YELLOW”, “GROUND” and “FIRST”. 05 sample Commands are now saved to the Module and ready to use for the final application. (Figure 9).

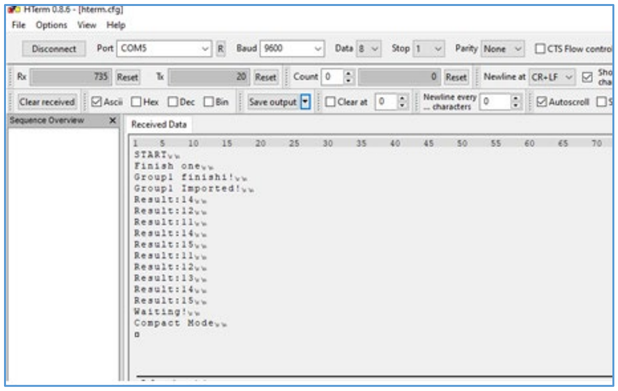

Figure 10. Recorded 05 commands in HTerm

Method and Connections for Part 2 is ATmega328P Microcontroller, Servo motor or Stepper Motor, L293D motor driver for DC Motor, Voice Recognition module connected Microcontroller (Figure 10)., GND to GND, RXD to TXD, TXD to RXD & VCC to +5V respectively.05 Commands saved with Module ready for use. Connected 03 LED's Green, Red and Yellow color to Bread board & Connected Active Buzzer (Figure 10).

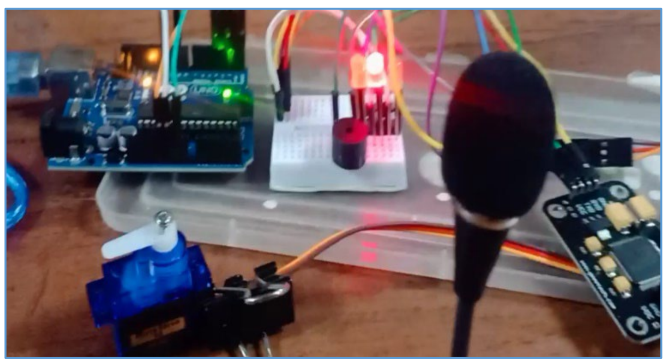

Figure 11. Experiment Setup for Command operation showing Motor, 03 LED's, Microphone and Voice Module

While Command is "first" and Lift is available, LED turns yellow, Active Buzzer is on, Display shows "welcome", Play back sounds "welcome" while Buzzer turns off. In case the command is "ground", LED turns Red, Buzzer keeps off and Display shows "please wait", Play back sounds "please wait" (Figure 11). While command is "ground" and Lift is available, LED turns Green, Buzzer is on and Display shows "welcome", Play back sounds "welcome" while Buzzer turns off, In case Command is "first" then LED turns Red, Buzzer keeps off and Display shows "please wait" and Play back sound "please wait".

5. Results and Discussion

Block Diagram shows the process used for recording the Training commands via Microphone and storing the data to microcontroller SPCE061A using serial communication.

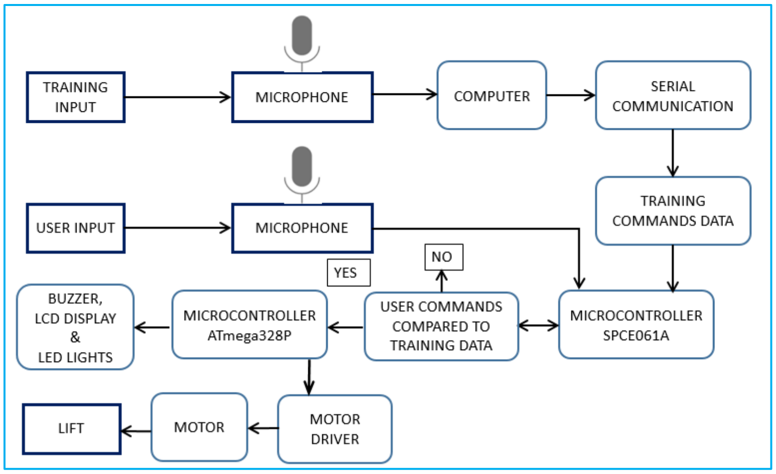

Figure 12. Block Diagram of the Voice Command Operation

Then separately the 05 commands are tried via Microphone to find that is internally compares those 05 commands with training data and excepts in case the echowayves matched to it or rejects when it does not. (Figure 12). During final experiments it is found that the system recognizes male voice commands of middle aged adult persons. To validate that few students were requested to use the Microphone attached to the prototype and found that from the available 8 out of 10 Male students and 02 out of 10 Female students were able to operate the system successfully. The ATmega328P microcontroller connected to the Buzzer, LCD Display and LED lights logically signaled as per program and in turn Motor driver module accepted the voice commands to drive the Motor at 90 degree and 180 degree as expected.
Below is the summary of operations related experiments conducted along with respective result. (FEA Results of Mechanical structure is not considered here) (Table 1).

Table 1 . Summary of Experiment results

Index	Description	Result
Exp. 1	Identify & Test the Hardware for Testing of Obstacle Sensor	Buzzer activates successfully and sets alarm when the wheelchair approaches the smart lift gate and is close to 01 feet safety distance for testing, thus sensor will further switch off (normally on) and opens the gate while LCD display shows the proximity distance.
Exp. 2	Identify & Test the Hardware for Voice recording and play back as per given Logic.	If distance sensor 1 at ground floor reads 1 feet, play back" welcome to the ground floor". If distance sensor 2 at first floor reads 1 feet, play back "welcome to the first floor" .
Exp. 3	Identify & Test the Hardware for Voice rrecognition, Software for same and Testing of Commands to operate the Motor.	Part 1 A: The Experiment failed to recognize the Hex Format generated commands using “Access Port software”, As It is concluded that “Hex” format does not work with ATmega328P microprocessor board.
		Part 1 B: The Experiment is successful and it converts & recognizes the ASCII Format using ATmega328P, SPCE061A Sound controller. Decodes 05 voice commands to Hex format using “H Term software” during the Part 2 of the final experiment.
		Part 2: Motor Drives on “Ground” Command and moves 90 degree as defined, motor drives to “First” ccommand and moves 180 degree as required, First Floor Status turns Green, Ground Floor Status turns Yellow and Lift Not Available Status turns Red.

5.1. Proposed Improvements

1. Database of speech commands study using other technologies, experiment to use them for actuation purposes.
2. AI and Machine Learning to identify the suitable algorithm and database for the subject for multi-speaker independently operated system or acoustically different voice commands.
3. Currently this system recognizes Male voice commands of Middle aged adult persons. Randomly available 8 out of 10 Male students and 02 out of 10 Female students were able to operate the system. Further work required to collect, experiment and use Female, old aged people, different type of disabled person's voice commands.
4. Basic Prototype of Voice Command Operation controller required to be converted to be more user friendly.
5. Reduce the overall cost of entire Project.

6. Conclusion

A Stationary, floor mount Smart Vertical Lift designed for the elderly, disabled and is useful for about 97% category of the overall Disability types. Most of Disable person with Voice Command can operate the lift. The studies carried out during the development of the Design marks a step forward towards the development of a special lift facility. Thus, befriending Assistive technology of this lift the quality of life of the elderly and the disabled could be improved by 10% increasing their self-esteem, self-confidence and happiness levels and thereby making world a better place to live.

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