International Journal of Advanced Research in
Electronics, Communication & Instrumentation Engineering and Development
Volume: 2 Issue: 3 26-Nov-2014,ISSN_NO: 2347 -7210

VOICE AUTOMATED WHEELCHAIR

Abhyuday S Kate[1], Shambhavi R Godbole[,2], Parikshit Jagtap[3],
Jay Kanakiya[4], Prof. D.G.Kanade[5]
Student, B.Tech Electronics[1,2], student, B.Tech Electronics and Telecommunication[3,4],
Professor Department of Electronics and Telecommunication[5].
Vishwakarma Institute of Technology, Pune

ABSTRACT---*The aim of this project is to develop a voice operated wheelchair which is ergonomic enough to be operated and understood by people of all age groups without the need of any additional help. Also, the end product must not be held back by any linguistic barrier and must enable universal usability. Thus, the need for a robust and comprehensive voice recognition and processing system looking beyond the traditional approaches arises. To meet the above objectives, the de-sign of the wheelchair is such that it incorporates minimum possible user interface, self-reliant circuits to accurately recognize voice and generate proper response in a time period as little as possible using hardware which can be easily procured, repaired and maintained. The wheelchair uses an onboard power supply which lasts all day for domestic use and can be charged while the wheelchair is not in use. Thus hardware and software design and implementation regarding this project was carried out keeping in mind the above goals and the project was completed within the anticipated time frame.*

INTRODUCTION

Some people find the operation of the traditional wheelchair a great physical strain because of old age or because of weakness or disability in their hands. For aiding such people; a voice automated wheelchair is a useful hands free system which moves the wheelchair based on the human voice inputs to the system. The aim of the project is to develop a fully functional, practically applicable, light weight, efficient, ergonomic and commercially viable voice automated wheelchair.

The primary requirement of the project is that the entire system should be easy to under-stand and operate for people of all age groups. This includes the people who are actually to use the system and also those people who are to assist the people using the system. Thus, the entire system has to be designed in such a way that it must be robust enough to operate efficiently un-der all conditions safely, considering various parameters of use and must be kept simple enough to be used by a layman as mentioned above.

The project falls under the stream of Embedded systems/ Mechatronics and the topic was chosen based on the following parameters:

1. Availability of hardware.
2. Possibility of implementing voice recognition in multiple ways.
3. Flexibility in implementing hardware design.
4. Hands-on experience in use of sensors, their interfacing with microcontroller and their mutual integration so as to form one independent system functioning based on various dependent parameters.
5. Scope of study of various speech processing algorithms and techniques implemented in the form of ICs, hardware and software integration.

Thus, with the above design considerations the system is expected to achieve its goals based on user and performance requirements.

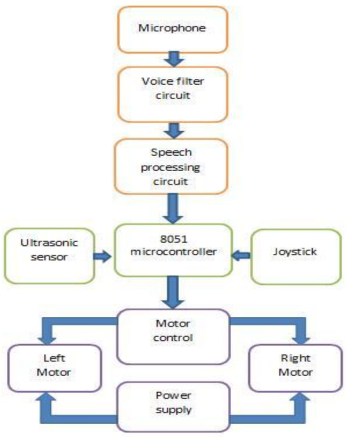


Figure 1.1: Command Architecture of Electronic Circuit

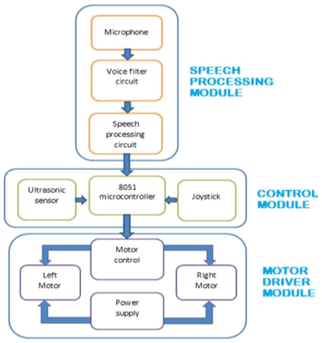


Figure 3.1: Functional Division of Block diagram

MODULES:

1. The Speech Processing Module
2. The Control Module
3. The Motor Driver Module

3.2 The speech processing module

This module comprises of all electronic circuits and components associated with voice detection, recognition and processing. The two major circuits working in this module are the voice filtering circuit and the voice recognition and processing circuit. Both of these circuits comprise of various components working together to achieve the desired goal. This section describes the design and working of each of these circuits and technical specifications of every component used in the circuits.

Below figure shows the detailed block diagram of this module comprising of individual components and their interconnection:

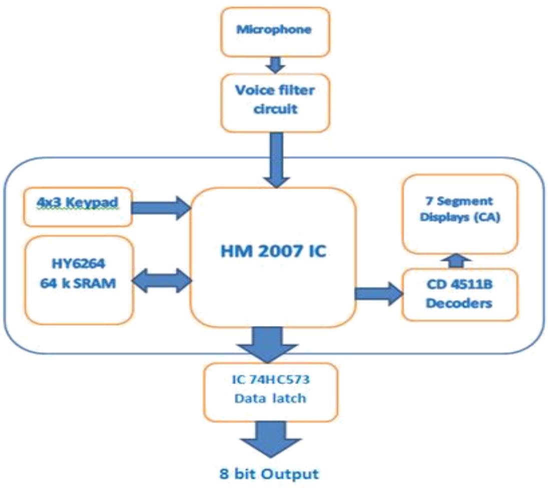


Figure 3.2: Speech processing module Block diagram

3.2.1 VOICE INPUT AND FILTERING

The first stage of speech processing is voice detection. In this circuit, the voice input is sensed by a PCB mounted, general purpose, low impedance, omni directional microphone. The technical specifications of the microphone are described below.

Based on the above described specifications, it can be concluded that this microphone is ideal for operation on a PCB and consumes a very low magnitude of power.

TABLE 3.1: MICROPHONE SPECIFICATIONS

Parameter	Value	Unit
Frequency Response	50-12000	Hertz
Impedence	300	Ohm
Operating Voltage	Std. 4.5: Max 1.5 - 10	Volts
Dimensions	10x7	mm
SNR	40	NA
Current Drain	0.4 (Max)	mA
Max. Input	120	dB SPL

The microphone has an input frequency range of 50Hz to 12 KHz. This leads to sensing of many unwanted signal from the surrounding. The function of filtering out the noise and band limiting the input from the microphone is done by a simple band pass filter which blocks signal beyond 300Hz and 3.1 KHz. This is the range of the human voice. This circuit uses two operational amplifiers to filter out the unwanted components of the microphone input.

This circuit passes frequencies in the 300Hz - 3.1 kHz range, as present in human speech. The circuit consists of cascaded high-pass and low-pass filters, which together form a complete band-pass filter. One half of a TL072 dual op amp (IC1a) together with two capacitors and two resistors make up a second-order Sallen-Key high-pass filter. With the values shown, the cut-off frequency (3dB point) is around 300Hz. As the op amp is powered from a single supply rail, two 10kO resistors and a 10F decoupling capacitor are used to bias the input (pin 5) to one-half supply rail voltage

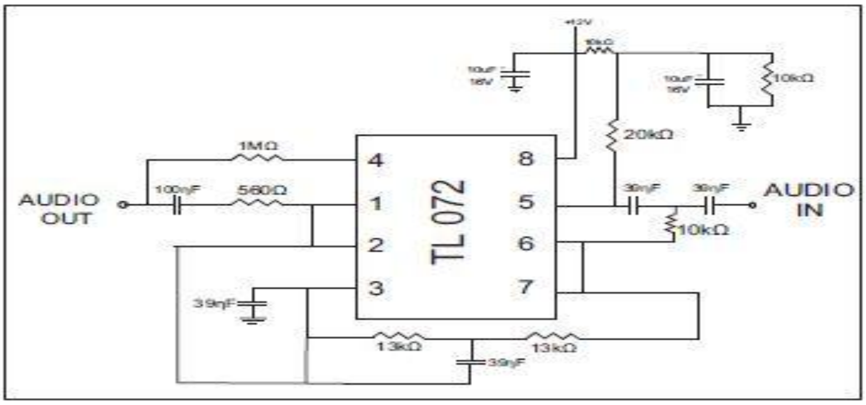


Figure 3.3: Voice Filter circuit

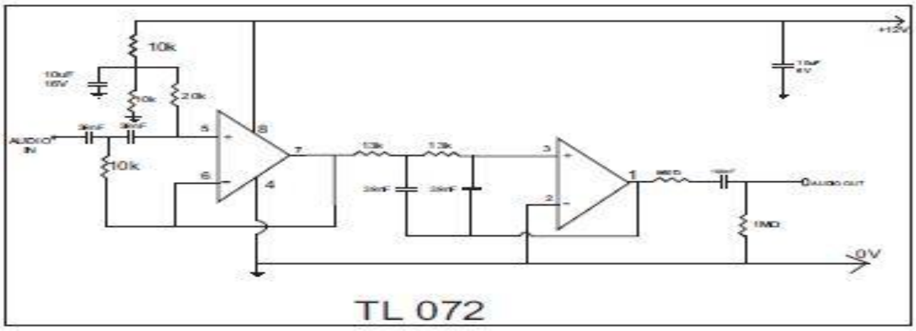


Figure 3.4: Internal structure of IC TL072

The output of IC1a is fed into the second half of the op amp (IC1b), also configured as a Sallen-Key filter. However, this time a low-pass function is performed, with a cut-off frequency of about 3.1kHz. The filter component values were chosen for Butterworth response characteristics, providing maximum pass-band flatness. Overall voltage gain in the pass-band is unity (0dB), with maximum input signal level before clipping being approximately 3.5V RMS. The 560O resistor at IC1b's output provides short-circuit protection.

3.2.2 VOICE RECOGNITION AND PROCESSING UNIT

This circuit unit is responsible for recognizing the human voice input detected and filtered by the previous stages of the module.
This circuit unit comprises of various components as described below:

1. HM 2007 IC
2. HY 6264 SRAM

3. IC 74HC573 as on output latch

4. IC CD4511B to interface CC 7-segment displays

5. A LM 7805 based power regulator circuit

The voice recognition and processing tasks of this circuit unit is carried out by the HM 2007 IC. The HM 2007 IC is supported by a static RAM for storing commands with which voice commands are compared with. The generated output; i.e., the result of comparison is delivered to IC 74HC573. This IC latches the output so that it can be used by the next module of the system. This unit also provides for the user interface of the system. The user trains the system using the keypad and following a set of rules. This keypad is placed at the armrest of the wheelchair for convenient use. Along with the keypad, the wheelchair has two seven segment displays. These displays serve the user with information regarding the status of the system and voice recognition in terms of output codes.

The below text highlights the technical specifications and working of each of the compo-nents mentioned above. Also it explains the functions of every component with regard to the entire module.

HM 2007 IC

This IC is the heart of the speech recognition and processing module. It is solely responsible for recognition and processing of the human voice inputs.

The various technical specifications of this IC are:

It is a single chip CMOS voice recognition LSI circuit with an on chip analog front end, voice analysis, recognition process and system control.

The IC is available in two packages: 48 pin PDIP and 52 pin PLCC. The 52 pin PLCC package is used as it provides for a more compact circuit configuration.

The IC runs on a 5V single power supply and draws 0.5 amperes current form the source. It has two control modes: Manual mode and CPU Mode.

It has a response time of less than 300ms.

Maximum supported word duration: 1.92s with 20 words capacity. Maximum word number support: 40 with 0.92 word duration.

International Journal of Advanced Research in

Electronics, Communication & Instrumentation Engineering and Development

Volume: 2 Issue: 3 26-Nov-2014,ISSN_NO: 2347 -7210

For this project, the 52 pin PLCC package has been used as the resultant circuit is compact as compared the circuit using the PDIP package and this package is readily available. The pin diagram and functions of this package are described below:

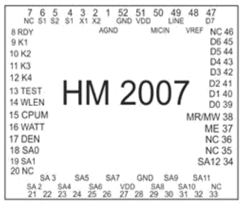


Figure 3.5: Pin Diagram of HM2007

HY 6264 SRAM

The HY6264 is a high-speed, low power, CMOS static RAM. This Static RAM is used for storing the words with which the HM 2007 IC is trained. Below are the features of the RAM:

8K x 8 bit; i.e.; 64K CMOS SRAM

Fully static operation with tri-state output TTL compatible inputs and outputs

Available in two packages: 28 pin 28mil PDIP dual inline and 28 pin 330mil SOP small outline

RAM used in the circuit is 28mil PDIP package. Operates at 5V (up to 7V max.).

Draws 50mA current from the supply. Rated power dissipation 1W.

Battery backup (L/LL-part) -2.0V (min.) data retention.

The below figure shows the pin diagram of the PDIP package:

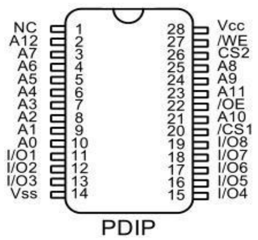


Figure 3.6: Pin Diagram of HY6264 SRAM

IC 74HC573

The 74HC573; 74HCT573 is a high-speed Si-gate CMOS device. This IC is used as a latch to continuously supply the next module with the output code generated by the HM2007 IC. This is needed as the HM2007 IC gives out the output just once and the next stages of the circuitry and the output display units require continuous output.

The basic features of this IC are:

Input levels: For 74HC573: CMOS level.
Inputs and outputs on opposite sides of package allowing easy interface with micropro-cessors.

3-state non-inverting outputs for bus-oriented applications.

The internal latching mechanism of the IC is shown below in conjunction with the pin diagram:

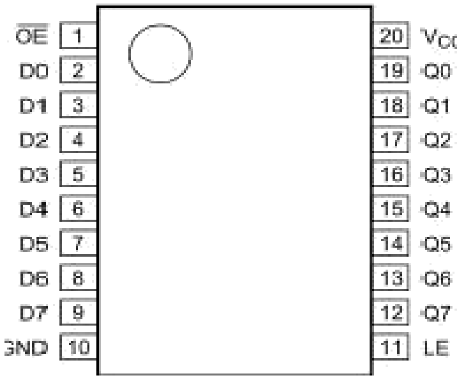


Figure 3.7: Pin Diagram of IC 74HC573

International Journal of Advanced Research in

Electronics, Communication & Instrumentation Engineering and Development

Volume: 2 Issue: 3 26-Nov-2014,ISSN_NO: 2347 -7210

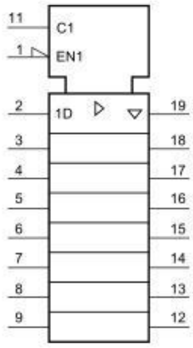


Figure 3.8: Logic Diagram of 74HC573

The 74HC573; 74HCT573 has octal D-type transparent latches featuring separate D-type inputs for each latch and 3-state true outputs for bus-oriented applications. A latch enable (LE) input and an output enable (OE) input are common to all latches. When LE is HIGH, data at the Dn inputs enter the latches. In this condition, the latches are transparent, i.e. a latch output changes state each time its corresponding D input changes.

When LE is LOW the latches store the information that was present at the D-inputs a set-up time preceding the HIGH-to-LOW transition of LE. When OE is LOW, the contents of the 8 latches are available at the outputs. When OE is HIGH, the outputs go to the high-impedance OFF-state. Operation of the OE input does not affect the state of the latches.

IC CD4511B

This is a BCD to seven segment decoder IC which is used to interface the seven segment displays with the HM 2007 circuitry to display the output codes. This is constructed with CMOS logic and NPN BJTs.

The basic features of this IC are:

It has a high output sourcing capability up to 25mA. 16-lead hermetic dual-in-line ceramic package.

SUPPORTS BLANKING AND LAMP TEST.

Works on a voltage of 5v and draws 10mA current from the circuit.

This IC accepts BCD input from the HM2007 circuit and decodes it. The driver is respon-sible for sourcing the required power for operation of the seven segment displays. The type of seven segment display used is of the common cathode ty

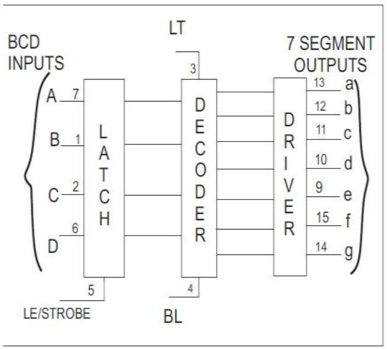


Figure 3.9: Functional Diagram of IC CD4511B

POWER REGULATOR USING LM7805

The LM7805 is a three-terminal positive regulator and is available in the TO-220 package and with several fixed output voltages, making it useful in a wide range of applications. This circuit employs internal current limiting, thermal shut-down, and safe operating area protection. If adequate heat sinking is provided, it can deliver over 1 A output current. Although designed primarily as fixed- voltage regulators, it can be used with external components for adjustable voltages and currents.

The basic features of this regulator IC are

Output Current up to 1 A. Input voltage: 9 12V.

Output Voltage: 5V.

Thermal Overload Protection. Short-Circuit Protection.

Output Transistor Safe Operating Area Protection.

This circuit is used to convert the 12V DC supply obtained from the battery into a 5V supply for the speech recognition and processing circuitry.
Below figure shows the circuit connections of the LM7805 with supporting circuitry

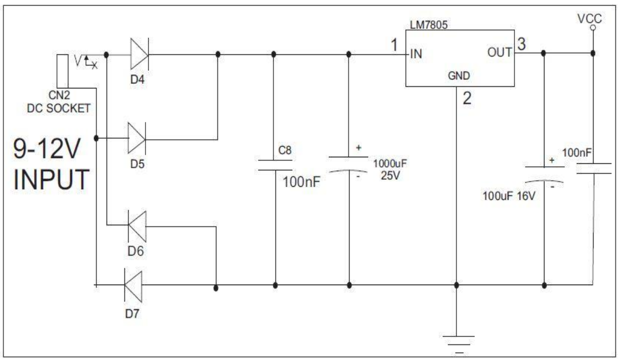
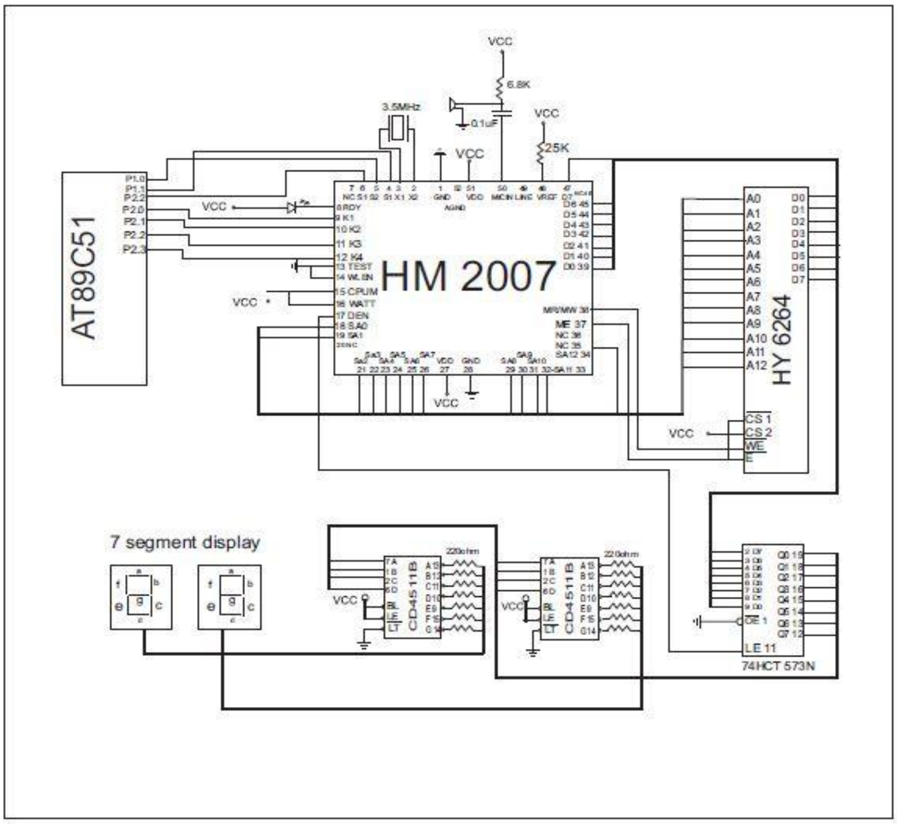


Figure 3.10: Power Regulator circuit

INTERFACING OF CIRCUIT COMPONENTS OF SPEECH PROCESSING MODULE

The below figure shows the interfacing of various components described above to form a properly functioning circuits.



HY6264 HM2007 INTERFACING

The address and data connections between the SRAM and HM2007 IC comprise of a 16-bit address bus and an 8-bit data bus. The address bus of the HM2007 IC branches out of pins 18, 19:25, 26, 29:32 and 34 and are connected to pins 3:10, 23:25, 21 and 2 of the HY6264. The data bus coming out of pins 39:45 of the HM2007 IC is connected to pins 11:19 of the HY6264 SRAM. These connections are done by standard 8 pin parallel busses.

Pin number 38; i.e.; MR/MW (Memory read/write) pin of the HM2007 IC is connected to the /WE (Write Enable) pin of the HY6264 SRAM. The output end of this connection is on the HM2007 IC and the receiving end is on the HY6264 IC. The status of the MR/MW pin of the HM2007 decides the functioning of the write function of the RAM. When the MR/MW pin goes low, the write function of the RAM is enabled. Else, the RAM operates in the read mode. When the HM2007 IC stores data onto the memory of the RAM, this pin is set to low to allow the writing action on a memory location in the RAM. During voice recognition and comparison, this pin is set to high so as to read data previously stored on the RAM.

The ME (Memory enable) pin; i.e.; pin number 38 of the HM2007 IC is connected to the /OE (Output Enable) pin; i.e.; pin number 22 of the HY6264 SRAM. The output end of this connection is on the HM2007 IC and the receiving end is on the HY6264 IC. The status of the /OE pin on the RAM decides the output operation of the RAM. This is an active low pin indicating that the output mode will be active when this pin receives a low input. When data needs to be sent to the HM2007 IC for the purpose of recognition and comparison, this pin is set to low. Otherwise, this pin remains high.

HM2007- OUTPUT CONNECTIONS

The output codes generated by the HM2007 IC are sent to the output latch (IC 74HC573) via the 8-bit data bus. This serves the purpose of latching the output once it is given out by the HM2007 IC. The data bus pins 39:45 of the JM2007 IC are connected to pins 2:9 of the 74HC573 IC. The DEN (Data Enable) pin; i.e.; pin number 17 of the HM2007 IC is connected to the 11th pin; i.e.; the /LE (latch enable) pin of the IC 74HC573. When the Latch Enable pin of the 74HC573 IC goes low the IC latches the input it receives from pins 2:9 to output pins 12:19.

The output is given out to the next module of the system as input and is displayed on two seven segment displays interfaced with the main circuit by the CD4511B BCD to seven segment decoder IC.

Working of the voice recognition module using HM 2007 based circuit

Voice recognition using the HM 2007 based speech processing circuit is a three step process:

1. Power on
2. Kit training
3. Voice recognition

Power ON mode:

During the power on mode, the circuit initializes all components for training and voice recognition. The WAIT pin of this IC is connected to HIGH i.e. initiated to logic 1. Once the circuit gets power supply the status of the WAIT pin (16) is checked. Input signal to this pin is supplied by the RAM. If WAIT is Low, the HM 2007 IC will check if 64K SRAM IC HY6264 is perfect or not. If WAIT pin is high the HM 2007 will skip the memory check process. Memory check of SRAM is recommended for its optimum use. Once the process under power on mode is executed the unit keeps checking the status of WAIT till it is HIGH. If WAIT is high the HM2007 pulls down RDY pin (ready) to low. This pin is connected to cathode of a light emitting diode whose anode is connected to Vcc. Thus the LED turns ON when RDY is low i.e., it gives a signal to the user to choose one of the modes between

TRAINING OR CLEARING MODE RECOGNITION MODE.

The choice between modes is dependent on the type of input fed to the unit. If input is a voice signal it will go to recognition mode. If input is from keypad it will go in training or clearing mode.

TRAINING OR CLEARING MODE

Before voice recognition is carried out, the training of the HM2007 based circuit is necessary. The training process accepts voice inputs and store his voice pattern in the RAM for matching with voice inputs from the user during the recognition stage. The keypad used for training is connected to the IC HM 2007 as S1,S2,S3,K1,K2,K3 and K4 to 4,5,6,9,10,11 and 12th pin of IC respectively.

The user trains or clears the HM2007 IC by pressing the number code corresponding to the input and pressing the train key (#) or clear key (). After doing so, the HM207 IC sets the MR/MW pin to low and the ME and RDY pins to high enabling the HM2007 IC to store the voice input pattern on to a memory location in the SRAM while disabling the output read mode of the SRAM and indicating to the user that the circuit is not ready to accept voice commands.

In the training mode, once the MR/MW pin goes low and the ME pin goes high, the RDY pin goes low and the LED glows indicating that the HM2007 IC is ready to accept users voice input. The pressed key number is sensed by HM 2007 and the corresponding input/output code is generated on data out pins D0 to D7 and the voice signal is stored on to a memory location in the RAM. Once this process is complete, the MR/MW pin of the HM2007 IC goes high and the ME pin goes low disabling the memory write operation, enabling the memory read operation and enabling the output read operation of the RAM. This also gives out a low signal to the RDY pin indicating to the user that the circuit is ready to accept new voice commands for recognition or is ready for training.

For example, if one presses key 55 the data output pins will be assigned values as [D0 D1 D2 D3 D4 D5 D6 D7 D8]= [0 1 0 1 0 1 0 1]

This data is given to SRAM IC HY6264 and the latch IC 74HC563.The RAM stores this 8 bit data. The output of latch is given to display and microcontroller (for programming purpose). The latch doesn’t latch this signal till latch enable signal is provided to latching IC 74HC573. Thus HM 2007 send a latch enable signal via DEN pin (17). It is assigned a logical one. This enables latch and displays the corresponding decimal numbers on CC seven segment displays.

For example,

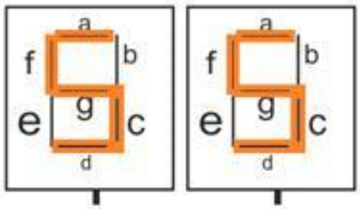


Figure 3.12: 7 segment Display

In the clearing mode, all the data stored in the HY6264 SRAM memory is wiped out and the circuit needs to be trained again.

CLEARING FUNCTION

If CLR is pressed, clearing function takes place. The module clears the word corresponding to the number pressed on the keypad and returns back to SELECT VOICE INPUT OR KEYPAD INPUT state as shown in the process flow.

RECOGNITION MODE

The HM2007 IC configures itself in this mode by setting the MR/MW and the RDY pin to high and the ME pin to low, thereby setting the RAM in the memory read and the output enable mode while indicating to the user that the circuit is busy. Once this configuration is completed, the HM2007 IC sets the RDY pin to low leading to the glowing of the LED indicating to the user that the circuit is ready for voice commands.

Once a voice command is sensed by the circuit, it sets the RDY pin to high until the recognition process is completed. The input voice command of the user is compared with the preloaded voice commands in the RAM and based on the results of comparison; an output code is generated.

Once an output code is generated, the HM2007 IC sets the DEN pin to low enabling the latch to display the output codes to the seven segment display and makes the output available to the next module.

After completion of the above process, the HM2007 IC sets the RDY pin to low thereby glowing the LED and indicating to the user that the circuit is ready for recognition. The entire process takes less than 300ms for completion.

3.3 CONTROL MODULE

3.3.1 MICROCONTROLLER

In this project, the AT89S51 microcontroller is used to accept inputs from the speech processing module and send out respective control signals as outputs.

The AT89S51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). By combining a ver-satile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89S51 is a powerful entry level microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

The S in 89S51 refers to system programming. Important Features of 89S51:-

8-bit ALU and Accumulator, 8-bit Registers (one 16-bit register with special move in-structions), 8-bit data bus and 2x16-bitaddress bus/program counter/data pointer and related 8/11/16-bit operations; hence it is mainly an 8-bit microcontroller

Boolean processor with 17 instructions, 1-bit accumulator, 32 registers (4 bit-addressable 8-bit) and up to 144 special 1 bit-addressable RAM variables (18 bit-addressable 8-bit)

Multiply, divide and compare instructions

4 fast switchable register banks with 8 registers each (memory mapped) Fast interrupt with optional register bank switching

Interrupts and threads with selectable priority

Dual 16-bit address bus It can access 2 x 216 memory locations 64 kB (65536 locations) each of RAM and ROM

128 bytes of on-chip RAM (IRAM)

4 KB of on-chip ROM, with a 16-bit (64 KB) address space (PMEM). Not included on 803X variants

Four 8-bit bi-directional input/output port UART (serial port)

Two 16-bit Counter/timers

Power saving mode (on some derivatives)

The 89S51 has been used in this project to control the motors according to the input given from the speech processing module and the joystick and to read data from the ultrasonic sensor and generate control signals accordingly.

Microcontroller selection criteria

The 89S51 microcontroller is easily available.

89S51 has inbuilt interrupt Service Mechanisms and routines.

89S51 is cheaper than in comparison with other AVR and ARM microcontrollers. It has 4 input output ports which completes the requirements.

It has got the two inbuilt timers/counters on the chip.

8 bit microcontroller can easily handle the control operations.

Easier to upgrade to higher performance micro-controller using the same code.

4K Bytes of In-System Reprogrammable Flash Memory, 128 x 8-bit Internal RAM which is satisfactory for the program.

INTERRUPTS IN 89S51:

Interrupts are an important part of 8051 microcontroller which are events that inform the micro-controller that a device needs its service. The program associated with it is called as interrupt service routine (ISR).Upon receiving the interrupt the microcontroller finishes its current in-struction and saves the Program Counter on the stack.

To use the interrupts, the EA that is Enable All Pin is made HIGH .EA pin is the global enable / disable PIN. The corresponding interrupt PIN is also made HIGH depending upon which interrupt we are using. For example, if we are using the external interrupt 0 then EX0 pin is made HIGH.

TIMERS IN 89S51

The 8051 microcontroller has two 16-bit timers Timer 0 (T0) and Timer 1(T1) which can be used either to generate accurate time delays or as event counters. These timers are accessed as two 8-bit registers TLO, THO & TL1, TH1 because the 8051 microcontroller has 8-bit archi-tecture.
TIMER 0: The Timer 0 is a 16-bit register and can be treated as two 8-bit registers (TL0 & TH) and these registers can be accessed similar to any other registers like A, B or R1, R2, R3 etc.
The TMOD register decides the modes of the individual Timers. In Mode 0, the timer is 8 bit counter with TH0 as the prescalars that are the starting value of the register.

For example, if TH0 is equal to 180, the timer will count from 180 to 255 and give an overflow interrupt.

Ex: The instruction MOV TL0, #07 moves the value 07 into lower byte of Timer 0. As, we are using the Timer overflow the EA and ET0 pin is made HIGH.

PWM GENERATION

Pulse Width Modulation is used for starting and stopping the motor by varying the duty cycle from 0 deg to 180 deg and 180 deg to 0 deg respectively.

Pulse width generation is achieved by using timers and interrupts .To explain the generation of duty cycle lets consider that the duty cycle is 60%.Then the TH0 register will have value 153 for the high level and value 102(255-153) during Low cycle.

The interrupt service routine should also alternatively switch between high level and the low level according the previous value (pwm flag) and during each routine the interrupt has to be cleared and timer has to be reset. For faster development purposes we have used Keil for the development and debugging of the C code required for the 8051 microcontroller.

This module is responsible for controlling the wheelchair movements. The brain of this system is microcontroller. It takes in the input from speech processing module, ultrasonic sensor and joystick. These inputs are processed depending on their priority or predefined order. The output of the microcontroller is given to the driver module for current boosting and efficient working of motors.

3.3.2 OBSTACLE DETECTION

For the purpose of obstacle detection, the ultrasonic module HC SR04 is used in this system. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, with the ranging accuracy that can reach up to 3mm. The ultrasonic module includes ultrasonic transmitters, receiver and control circuit.

The basic working principle:

1. Using IO trigger for at least 10us high level signal

2. The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back

3. IF the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning

4. Depending upon the time taken by the signal to return, the range of the obstacle is calculated.

Test distance = (high level time velocity of sound (340M/S)) / 236VCC Trig Echo GND

Figure 3.14: Ultrasonic Sensor Module

The features of this module are:

1. Working Voltage :DC 5 V
2. Working Current :15mA
3. Working Frequency : 40Hz
4. Max Range : 4m
5. Min Range :2cm
6. Measuring Angle : 15 degree
7. Trigger Input Signal : 10uS TTL pulse
8. Echo Output Signal Input TTL lever signal and the range in proportion
9. Dimension : 45*20*15mm

A short 10Us pulse sis sent by microcontroller to the sensor to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion. User calculates the range through the time interval between sending trigger signal and receiving echo signal.

3.3.3 JOYSTICK

Figure 3.15: Joysick

For the backup controller system a joystick is used for navigating the wheelchair. A high quality 2-axis analog joystick module has been used which comes with a plastic knob for excel-lent feel during use.

It is used to sense movement in two directions or axes with an inbuilt switch which can be activated by pressing the stick. The joystick module has got standard 0.1 spaces headers for easy interfacing. The position of the pins is known from voltage at two output pins A1 and A2, this pins output 0 and Vcc when the stick is at the two extreme positions of the axis and when the stick is at other intermediary position, and the output is between 0 and Vcc corresponding to the position of stick. This output is interfaced with the microcontroller to obtain proper control signals with respect to the position of the stick along the two axes.

It is the perfect choice because of its standard headers, high quality analog system, easy interfacing with microcontroller and ergonomically shaped knob.

3.4 THE DRIVER MODULE

The motors used on the wheelchair use a large amount of current which cant be supplied by the controller and thus driver circuit is needed. This motor driver circuit used in the project makes use of two relays as medium for high power supply to the motors and N channel MOSFETs to control the ON/OFF status of the motors and to energize the relay coils for direction switching.

Below figure shows the schematic of the circuit used to achieve the desired result.

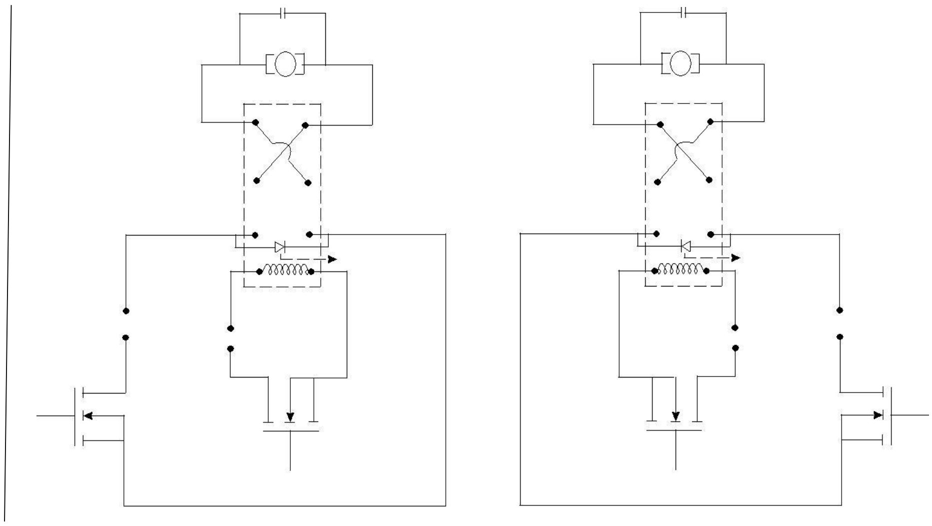


Figure 3.16: Battery

The below text highlights the useful features of the components used in the circuit.

IRF 540N channel MOSFET

This is a power MOSFET which supports up to 100 V drain to source voltage capable of driving up to 28 amperes of drain current to control the ON/OFF status of the motor using the control signals for the gate voltage from the microcontroller. The below are the basic features of this MOSFET.

1. Dynamic dV/dt Rating
2. Repetitive Avalanche Rated
3. 175 C Operating Temperature
4. Fast Switching
5. Ease of Paralleling
6. Simple Drive Requirements

Table 3.4: Pin Description of HY6264 SRAM

SYMBOL	PARAMETER	VALUE	UNIT
Vds	Drain to source voltage	100	V
Vgs	Gate to source voltage	-20	V
Id	Drain current	28	A

IRF 840 MOSFET

This MOSFET is used to energize the relay coils. This MOSFET turns ON by 5V of gate voltage obtained from the microcontroller. The turning ON of this MOSFET causes current to flow through the relay coils which in turn causes the relay coils to be energized. The relay coils need to be supplied with 2A of current in order to implement the switching action.

Relay

The relays used in the system are designed to carry high power at high values of current. The relay used has a voltage rating of 20V and a supported current rating of up to 16A.

The relay has four terminals. One of the terminals of the relay is connected to the power supply; i.e.; the onboard battery and is connected internally to the normally connected out-put terminal. Switching action of the relay connects the supply to the normally open terminal. Switching action is implemented by the terminal connected to the MOSFET IRF840 and switch-ing is done by turning ON this MOSFET by supplying gate voltage through the microcontroller. Silver Cadmium oxide (AgCdO) is used for the relay contacts for enhanced electrical life.

The relays used in the system are designed to carry high power at high values of current. The relay used has a voltage rating of 20V and a supported current rating of up to 16A.

The relay has four terminals. One of the terminals of the relay is connected to the power supply; i.e.; the onboard battery and is connected internally to the normally connected out-put terminal.

Switching action of the relay connects the supply to the normally open terminal. Switching action is implemented by the terminal connected to the MOSFET IRF840 and switch-ing is done by turning ON this MOSFET by supplying gate voltage through the microcontroller. Silver Cadmium oxide (AgCdO) is used for the relay contacts for enhanced electrical life.

Figure 3.17: Relay

3.4.1 POWER SUPPLY

Lead Acid batteries are the most economical for larger power applications and the preferred choice for hospital equipment, wheelchairs, emergency lighting and UPS systems.

Some parameters of Lead Acid batteries are:

Gravimetric Energy Density - 30-50(Wh/kg) Internal Resistance ¡100 mOhm.

Cycle Life - 500 to 1000.

Operating Temperature: -20 to 60C.

Figure 3.18: Battery

Advantages of Lead-Acid Batteries

Most reliable and economical

Low self-discharge the self-discharge rate is among the lowest in rechargeable battery systems.

Capable of high discharge rates.

Low maintenance requirements no memory; no electrolyte to fill.

3.4.2 MOTORS

The project uses two brushless DC Motors to drive the wheelchair. Each of these motors run on 12V supply and use 15A to generate 50Kg torque. Together, these motors are capable of driving up to 100Kg weight. Thus, these motors are sufficient to drive the wheelchair being operated by an average person.

A brushless DC motor consists of a current carrying armature which is connected to the supply end through commutator segments and brushes and placed within the north south poles of a permanent or an electro-magnet. The construction of a DC motor is such that the direction of electric current through the armature conductor at all instances is perpendicular to the field. Hence the force acts on the armature conductor in the direction perpendicular to the both uniform field and current is constant. In a brushless DC motor (BLDC), the permanent magnets are on the rotor and you move the electromagnets to the stator. Advantages of using Brushless Motors over Brushed Motors:-

Figure 3.19: Motors

There is no sparking and much less electrical noise so better efficiency. There are no brushes to wear out so longer life expectancy.

With the electromagnets on the stator, they are very easy to cool.

You can have a lot of electromagnets on the stator for more precise control useful for advanced Motor Control

SOFTWARE

4.1 MICROCONTROLLER PROGRAMMING AND WORKING

The microcontroller is used for generating proper control signals to drive the motors, implementing switching action of the relays and to implement obstacle detection using the ultrasonic sensor module. Below text describes the working of the microcontroller program.

ALGORITHM OVERVIEW OF THE PROGRAM:-

1. START
2. Port1 is declared as input from the voice control unit by setting it as 1.
3. The first six pins of PORT 0 are declared as output for motor control by setting it as 0.
4. Similarly P3 1 is declared as output and P3 5 is declared as 1 for the ultrasonic sensor.
5. Declare a continuous loop using while (1)
6. Get the range from ultrasonic sensor.
7. If that range is less than 5 or range = 0 then stop function is invoked.
8. Them according to the PORT1 input the motor is controlled accordingly.
9. If P1 = 0x02 then Forward function is invoked
10. If P1 = 0x04 then Turn Left function is invoked

11. If P1 = 0x06 then Turn Right function is invoked
12. If P1 = 0x08 then Reverse function is invoked
13. For Forward, PWM is varied from 0% duty cycle to 100% duty cycle for turning on the motors.
14. Similarly, PWM is varied from 100% duty cycle to 0% duty cycle for turning off the motors.
15. For going left, the right Motor is rotated forward while the left Motor is rotated backward.
16. A pulse with duration of 10 microseconds to the trigger pin of the ultrasonic sensor.
17. The echo pin is sensed for the returning echo pulse.
18. According to time difference the distance is calculated and returned.
19. END

WORKING OF THE MICROCONTROLLER CONTROL MODULE

The Atmel At89S51 microcontroller takes 3 inputs. One from the voice control module, one from the obstacle detection module and one from joystick module. It gives the control signals to the motor driver module which in turn will drive the motors according the condition.

Depending upon the mode select switch, the control may be automatic or manual that is according to the position of the voice control and recognition module or joystick. This will serve two purposes, joystick will be the backup control system and the voice commands can be used to activate the wheelchair.

The range is detected by sending a pulse of 10 microseconds to the trigger pin the obstacle detection module. The Timer is in Mode 0 and the stop by GATE flag is enabled so that the resulting echo should stop the timer. After a predefined amount of time, the THO register is checked for its value if that value is less than the predefined amount of time then it must have been stopped because of the trigger pulse. Therefore the distance can be calculated from the value of value in the TH0 register.

International Journal of Advanced Research in

Electronics, Communication & Instrumentation Engineering and Development

Volume: 2 Issue: 3 26-Nov-2014,ISSN_NO: 2347 -7210

The main loop will first check whether the distance measured using ultrasonic sensor is less than 5cm.If that distance is less, than the motors are stopped using PWM.

The next thing will be to check the voice control input and call the function accordingly. Suppose if 02 is assigned to forward motion then Forward function is called. The Forward , Stop , TurnLeft and TurnRight functions will check the previous position of the motors and then use PWM to soft start or soft stop individual motors.

Sufficient care also needs to be taken so that motors are soft started and soft stopped using Pulse Width Modulation so that no jerk is applied. PWM is generated using microcontroller by making use of Timers and Interrupts in such a way that square wave pulse varies from 0

If the switch is in manual mode, then joystick input is used to drive the motor driver circuit. The joystick is basically two potentiometers which give two values j1 and j2 ranging from 0 to VCC depending upon their position. According to this positions, the Forward, Stop , TurnLeft and Turn Right functions are executed.

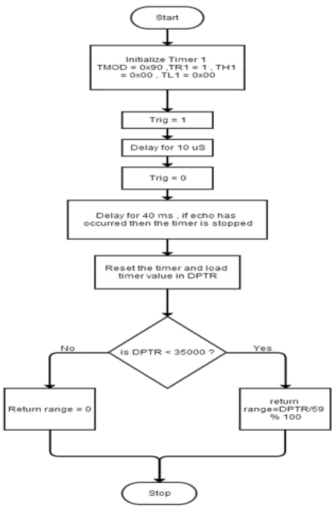


Figure 4.1: Flowchart of Main Program

International Journal of Advanced Research in

Electronics, Communication & Instrumentation Engineering and Development

Volume: 2 Issue: 3 26-Nov-2014,ISSN_NO: 2347 -7210

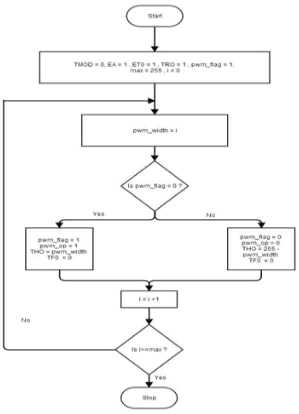


Figure 4.2: Flowchart of Ultrasonic Distance Sensing

MECHANICAL DESIGN AND ASSEMBLY

The wheelchair has to be designed in order to carry the weight of the person operating it, the weight of the battery and the weight of the mechanical assembly as well.

5.1 STRUCTURE

To make the wheelchair sturdy and lightweight at the same time, hollow steel rods with circular cross section were used for the design. Steel bars measuring 1 in diameter and 3mm in thickness were found to be adequate for this purpose.

To bear the weight of the assembly and of the person using the wheelchair, 16 steel rims supported by steel spokes have been used as the driving and weight bearing wheels. Small plastic wheels have been used in the front of the wheelchair for support. These front wheels have been attached to the vertical axle using omnidirectional bearings to facilitate turning.

Below the seat of the wheelchair, a platform has been attached to place the onboard battery and the circuit components such as the circuits for speech processing and recognition module, circuitry of the control module and the motors.

5.2 COMPONENT PLACING AND INTERFACING

Component placing plays an important part in making the wheelchair user friendly and easily understandable for people. To make the design as ergonomic as possible, all the user interface components have been placed on the armrest and the position of the microphone can be adjusted based on the users height and convenience.

Components placed in various locations of the wheelchair have been connected to each other using standard electronic ports and jumpers. The power components of the circuit such as the motor and the power transistors have been connected using 2mm multi-strand wire capable of carrying up to 20A of current.

Motors have been connected to the wheels by means of gears. The gears on the wheels are 1.5 times bigger than the gears on the motors to deliver proper RPM and torque.

The components of the driver circuit have been placed on a zero PCB extension of Micro-controller board. This makes the entire circuitry much more compact than spread out spacing and easily understandable. The entire control system and electronic circuitry has been placed under the chair on a rigid platform. This makes the wheel chair design compact and suitable for domestic use.

CONCLUSION AND FUTURE SCOPE

The design of the wheelchair was done following the V-model of mechatronics system design so as to yield a robust, efficient and agronomical product as the design output. The effort is focused on minimizing the UI required to handle the wheelchair which makes it easy to use for all users. This is done without compromising on the reliability and safety of the system which is provided for by a parallel control system and safety mechanisms based on electronic sensors.

The project is being completed in stages. Each stage comprises of development of a sub-system. Every sub system is then tested under various conditions of operation and is checked for faults. Once these faults are rectified, multiple sub-systems are then to be connected together by means of electronic, electrical and mechanical interfacing techniques. While interfacing it is of paramount importance that every stage is perfectly compatible with the stages that precede and succeed it. Thus, a major design effort is directed towards this. This gives shape to the final product which is the aim of this project.

The Voice automated has tremendous applications for disabled people. It can even be used for voice automated robots for doing extremely dangerous work not suitable for humans.

A pair of sensors can be connected underneath the wheelchair for the purpose of terrain sensing. The device comes to a halt once the sensors detect that there is no more surface to move on to or if the terrain is too steep for operation of the wheelchair. This measure aims to prevent the user from falling off the stairs or driving the wheelchair on to very steep terrain.

A camera can also be integrated in the system for advanced image processing and obstacle detection and avoidance.

Indoor Mapping using GPS and RFID systems can be interfaced within the system to allow even physically challenged persons to navigate through their homes by just uttering their place to go. This system can be even expanded into urban areas to let the users travel to their intended destinations by just uttering their locations. This can be done by integrating the system with any Maps API and path finding algorithms.

Infrared and camera sensors can be used to develop a model of the users current location and surrounding physical objects and by using some advanced path finding algorithms, the user can travel to their intended locations.

Overall, the main advantage will be more autonomy and giving power of locomotion back to the physically disabled persons.

BIBLIOGRAPHY

[1] Wheelchair for Physically Disabled People with Voice, Ultrasonic and Infrared Sensor Control; Kluwer Academic Publishers, Boston; MANUEL MAZO, FRANCISCO J. RO-DRIGUEZ, JOSI L. L, ZARO, JESI IS UREI A, JUAN C. GARCIA, ENRIQUE SAN-TISO, PEDRO REVENGA AND J. JESI IS GARCIA, Electronics Department, University of Alcald de Henares, Ctra. Madrid-Barcelona, 1995.

[2] Voice Operated Intelligent wheelchair; International Journal in Advance Research in Computer Science and Software Engineering; Ms. S. D Suryawanshi; Bharti Vidyapeeth, May 2013.

[3] Voice Controlled Intelligent Wheelchair; SICE Annual Conference; Masato Nishimori, Tottori University, 2007.

[4] Mechanical Principles of Wheelchair Design; Amos Winter, Massachusetts Institute of Technology.

[5] Microcontroller Implementation of a Voice Command Recognition System for Human Machine Interface in Embedded System; International Journal of Electronic Communication & Soft

Computing Science and Engineering; Sunpreet Kaur Nanda, Akshay P.Dhande.

[6] Low Cost Smart Home Automation via Microsoft Speech Recognition; International Journal of Engineering & Computer Science IJECS-IJENS; Md. Raihaan Kamarudin., Md. Aiman F. Md. Yusof, Faculty of Electronic and Computer Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

[7] Easy Image Processing: Camera Interfacing for Robotics; Daniel Herrington.

[8] VOICE CONTROLLED MOTORIZED WHEELCHAIR WITH REAL TIME OBSTACLE AVOIDANCE; Omair Babri, Saqlain Malik, Talal Ibrahim and Zeeshan Ahmed, Department of Electrical Engineering, University of Engineering and Technology, Lahore.

[9] Manufacturer: Hyundai; Product: HY6264B; Type: Static RAM.

[10] Manufacturer: HMC; Product: HM2007; Type: Voice Recognition IC.

[11] Manufacturer: Texas Instruments; Product: CD 4511B; Type: BCD to 7-Segment De-coder.

[12] Manufacturer: Fairchild; Product: LM7805; Type: Voltage Regulator.

[13] Manufacturer: NXP Semiconductors; Product: 74HC573; Type: Data Latch.

[14] Manufacturer: Vishay Siliconix; Product: IRF 540; Type: Power MOSFET.

[15] Manufacturer: Vishay Siliconix; Product: IRF 840; Type: Power MOSFET.

[16] Manufacturer: Atmel; Product: ATMega 32; Type: Microcontroller.

[17] Manufacturer: Atmel; Product: 89S51/89C51; Type: Microcontroller.

[18] Manufacturer: Salzer; Product: HSR16; Type: Relay.

[19] Manufacturer: Fairchild; Product: TIP31C; Type: Power BJT.

[20] www.msdn.com

[21] www.arduino.cc

[22] www.maxxtronic.com

[23] Developers.google.com

[24] www.github.com

[25] DipTrace user manual.

[26] Eagle user manual.