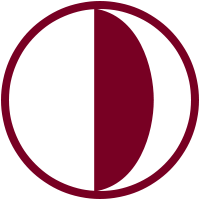
NEAR EAST UNIVERSITY



FACULTY OF ENGINEERING

ELECTRICAL POWERED WHEELCHAIR

Hasan Ozkan 20123742

Osman Galal 20110069

Alper Youssouf 20100222

Ramin Malikov 20102579

Graduation Project Thesis

Department Of Biomedical Engineering

Nicosia 2014

The undersigned, appointed by the dean of the Graduate School, have examined the entitled

**ELECTRICAL POWERED WHEELCHAIR**

presented by HASAN OZKAN,OSMAN GALAL,ALPER YUSUF,RAMİN MALİKOV

a candidate for the degree of Biomedical Engineering.

and hereby certify that, in their opinion, it is worthy of acceptance.

|  |
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| Professor Doç Dr.Terin Adalı |

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We,Hasan Ozkan,Alper Yusuf,Osman Galal and Ramin Malikov

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Electical Powered Wheelchair.

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# 

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# ABSTRACT

A electric powered wheelchair is a medical device which is powered by electrical sources in order to help disabled people to move the chair without using any mechanical force. This device will provide movement of disabled people..We have used a PC mouse in order to control a wheelchair. This will help disabled people to move without using their arms or another peoples’ help.Sometimes disabled people can only move their hands but not their arms so this is the main reason why we have used a PC mouse to control the wheelchair.

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# LIST OF ABBREVIATIONS

**Ohm(Ω):** Unitofelectricalresistance.

**V:** Voltage

**C:** Current

**W:** Watt

**BPM:** Beat Per Minute

**Sec(S):** Second

**mS:** Millisecond

**µ:** Micro

**m:**Milli

**k**: Kilo

**Hz:** Hertz

**Mm**: millimeter

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# HISTORY OF WHEELCHAIR

It is uncertain as to what can be considered the first wheelchair, or who invented it. The first known dedicated wheelchair (invented in 1595 and called an invalids chair) was made for Phillip II of Spain by an unknown inventor. In 1655, Stephen Farfler, a paraplegic watchmaker, built a self-propelling chair on a three wheel chassis.

### The Bath Wheelchair

In 1783, John Dawson of Bath, England, invented a wheelchair named after the town of Bath. Dawson designed a chair with two large wheels and one small one. The Bath wheelchair outsold all other wheelchairs throughout the early.

### Late 1800s

However, the Bath wheelchair was not that comfortable and during the last half of the 19th century many improvements were made to wheelchairs. An 1869 patent for a wheelchair showed the first model with rear push wheels and small front casters. Between, 1867 to 1875, inventors added new hollow rubber wheels similar to those used on bicycles on metal rims. In 1881, the pushrims for added self-propulsion were invented.

### The 1900s

In 1900, the first spoked wheels were used on wheelchairs. In 1916, the first motorized wheelchair was manufactured in London.

# The Folding Wheelchair

In 1932, engineer, Harry Jennings, built the first folding, tubular steel wheelchair. That was the earliest wheelchair similar to what is in modern use today. That wheelchair was built for a paraplegic friend of Jennings called Herbert Everest. Together they founded Everest & Jennings, a company that monopolized the wheelchair market for many years. An antitrust suit was actually brought against Everest & Jennings by the Department of Justice, who charged the company with rigging wheelchair prices. The case was finally settled out of court.

# First Motorized Wheelchair - Electric Wheelchair

The first wheelchairs were self-powered, and worked by a patient turning the wheels of their chair manually. Of course, if a patient was unable to do this, another person would have to push the wheelchair and patient from behind. A motorized or power wheelchair is one where a small motor drives the wheels to revolve. Attempts to invent a motorized wheelchair were made as far back as 1916, however, no successful commercial production occurred at that time.

The first electric-powered wheelchair was invented by [Canadian inventor](http://inventors.about.com/od/cstartinventions/a/Canadian.htm), George Klein and his team of engineers while working for the National Research Council of Canada in a program to assist the injured veterans returning after World War II. George Klein also invented the microsurgical staple gun.

Everest & Jennings, the same company whose founders created the folding wheelchair were the first to manufacture the electric wheelchair on a mass scale beginning in 1956.

# MANUFACTURERS AND EXAMPLES OF WHEELCHAIR

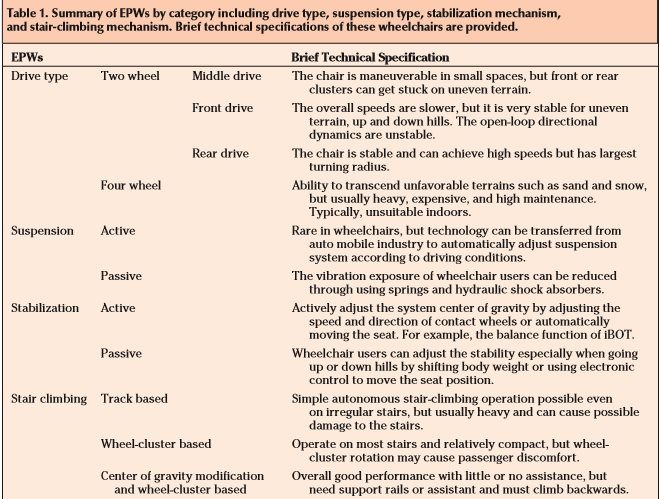


Table 1

# MANUFACTURERS AND EXAMPLES OF WHEELCHAIR

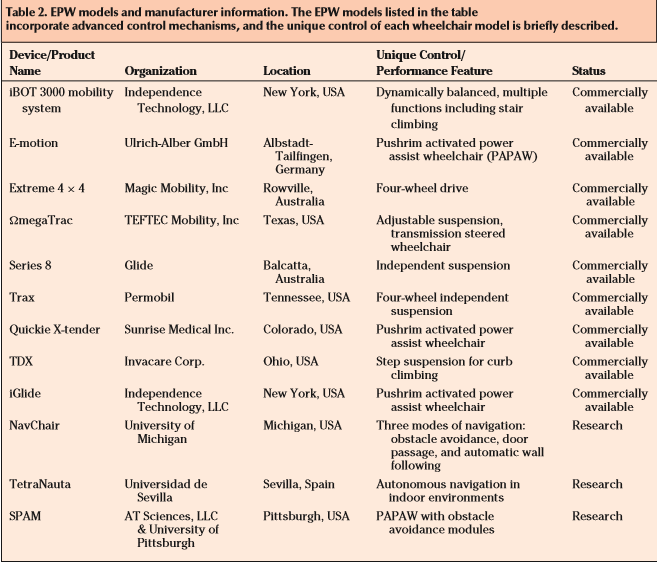


Table 2

# MATERIALS WE HAVE USED

* Relay
* Led Lights
* 12V D.C Motor (50-60) Rpm
* 12V 50Ah Battery
* Digital Voltmeter
* Astable multivibrator
* Wheels
* Horn
* Metal Frame

# MATERIALS WE HAVE USED

### Relay

A relay is an [electrically](http://en.wikipedia.org/wiki/Electric) operated [switch](http://en.wikipedia.org/wiki/Switch). Many relays use an [electromagnet](http://en.wikipedia.org/wiki/Electromagnet) to mechanically operate a switch, but other operating principles are also used, such as [solid-state relays](http://en.wikipedia.org/wiki/Solid-state_relay). Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance [telegraph](http://en.wikipedia.org/wiki/Electrical_telegraph) circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a [contactor](http://en.wikipedia.org/wiki/Contactor). [Solid-state relays](http://en.wikipedia.org/wiki/Solid-state_relay) control power circuits with no [moving parts](http://en.wikipedia.org/wiki/Moving_parts), instead using a semiconductor device to perform switching.



Figure 1

### Time delay relay

Timing relays are arranged for an intentional delay in operating their contacts. A very short (a fraction of a second) delay would use a copper disk between the armature and moving blade assembly. Current flowing in the disk maintains magnetic field for a short time, lengthening release time. For a slightly longer (up to a minute) delay, a [dashpot](http://en.wikipedia.org/wiki/Dashpot) is used. A dashpot is a piston filled with fluid that is allowed to escape slowly; both air-filled and oil-filled dashpots are used. The time period can be varied by increasing or decreasing the flow rate. For longer time periods, a mechanical clockwork timer is installed. Relays may be arranged for a fixed timing period, or may be field adjustable, or remotely set from a control panel. Modern microprocessor-based timing relays provide precision timing over a great range.

[](http://en.wikipedia.org/wiki/File:ACRelay.jpg)The high current of the cranking motor to be controlled with small wiring and contacts in the ignition key.

Figure 2

Electromechanical switching systems including [Strowger](http://en.wikipedia.org/wiki/Strowger_switch) and [Crossbar](http://en.wikipedia.org/wiki/Crossbar_Switch) telephone exchanges made extensive use of relays in ancillary control circuits. The Relay Automatic Telephone Company also manufactured telephone exchanges based solely on relay switching techniques designed by [Gotthilf Ansgarius Betulander](http://sv.wikipedia.org/wiki/Gotthilf_Betulander). The first public relay based telephone exchange in the [UK](http://en.wikipedia.org/wiki/UK) was installed in [Fleetwood](http://en.wikipedia.org/wiki/Fleetwood) on 15 July 1922 and remained in service until 1959.

The use of relays for the logical control of complex switching systems like telephone exchanges was studied by [Claude Shannon](http://en.wikipedia.org/wiki/Claude_Shannon), who formalized the application of [Boolean algebra](http://en.wikipedia.org/wiki/Boolean_algebra) to relay circuit design in [A Symbolic Analysis of Relay and Switching Circuits](http://en.wikipedia.org/wiki/A_Symbolic_Analysis_of_Relay_and_Switching_Circuits). Relays can perform the basic operations of Boolean combinatorial logic. For example, the boolean AND function is realised by connecting normally open relay contacts in series, the OR function by connecting normally open contacts in parallel. Inversion of a logical input can be done with a normally-closed contact. Relays were used for control of automated systemsfor machine tools and production lines. The [Ladder programming language](http://en.wikipedia.org/wiki/Ladder_programming_language) is often used for designing [relay logic](http://en.wikipedia.org/wiki/Relay_logic) networks.

Early [electro-mechanical computers](http://en.wikipedia.org/wiki/Mechanical_computer#Electro-mechanical_computers) such as the [ARRA](http://en.wikipedia.org/wiki/ARRA_(computer)), [Harvard Mark II](http://en.wikipedia.org/wiki/Harvard_Mark_II), [Zuse Z2](http://en.wikipedia.org/wiki/Zuse_Z2), and [Zuse Z3](http://en.wikipedia.org/wiki/Zuse_Z3) relays for logic and working registers. However, electronic devices proved faster and easier to use.

Because relays are much more resistant than semiconductors to nuclear radiation, they are widely used in safety-critical logic, such as the control panels of radioactive waste-handling machinery. Electromechanical [protective relays](http://en.wikipedia.org/wiki/Protective_relay) are used to detect overload and other faults on electrical lines by opening and closing [circuit breakers](http://en.wikipedia.org/wiki/Circuit_breaker).

### Leds

A light-emitting diode (LED) is a two-lead [semiconductor](http://en.wikipedia.org/wiki/Semiconductor) [light source](http://en.wikipedia.org/wiki/Light_source). It is a basic [pn-junction](http://en.wikipedia.org/wiki/Pn-junction) diode, which emits light when activated.[[6]](http://en.wikipedia.org/wiki/Light-emitting_diode#cite_note-6) When a suitable [voltage](http://en.wikipedia.org/wiki/Voltage) is applied to the leads, [electrons](http://en.wikipedia.org/wiki/Electrons) are able to recombine with [electron holes](http://en.wikipedia.org/wiki/Electron_holes) within the device, releasing energy in the form of [photons](http://en.wikipedia.org/wiki/Photon). This effect is called [electroluminescence](http://en.wikipedia.org/wiki/Electroluminescence), and the color of the light (corresponding to the energy of the photon) is determined by the energy [band gap](http://en.wikipedia.org/wiki/Band_gap) of the semiconductor.

An LED is often small in area (less than 1 mm2) and integrated optical components may be used to shape its [radiation pattern](http://en.wikipedia.org/wiki/Radiation_pattern).[[7]](http://en.wikipedia.org/wiki/Light-emitting_diode#cite_note-7)

Appearing as practical electronic components in 1962,[[8]](http://en.wikipedia.org/wiki/Light-emitting_diode#cite_note-LemelsonMIT-8) the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity, and limited to red. Modern LEDs are available across the [visible](http://en.wikipedia.org/wiki/Visible_spectrum),[ultraviolet](http://en.wikipedia.org/wiki/Ultraviolet), and [infrared](http://en.wikipedia.org/wiki/Infrared) wavelengths, with very high brightness.

Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of [seven-segment displays](http://en.wikipedia.org/wiki/Seven-segment_display), and were commonly seen in digital clocks.

Recent developments in LEDs permit them to be used in environmental and task lighting. LEDs have many advantages over incandescent light sources including lower energyconsumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are now used in applications as diverse as [aviation lighting](http://en.wikipedia.org/wiki/Navigation_light#Aviation_navigation_lights), [automotive headlamps](http://en.wikipedia.org/wiki/Automotive_lighting#Light_emitting_diodes_.28LED.29), advertising, [general lighting](http://en.wikipedia.org/wiki/Lighting), [traffic signals](http://en.wikipedia.org/wiki/Traffic_signal), and camera flashes. However, LEDs powerful enough for room lighting are still relatively expensive, and require more precise current and heat management than compact [fluorescent lamp](http://en.wikipedia.org/wiki/Fluorescent_lamp) sources of comparable output.

LEDs have allowed new text, video displays, and sensors to be developed, while their high switching rates are also useful in advanced communications technology.

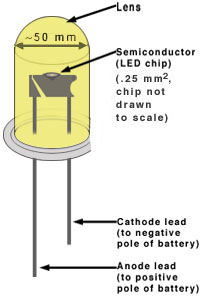


Figure 3

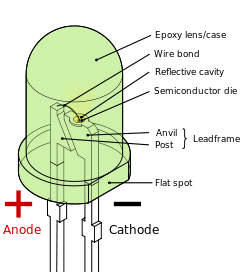


Figure 4

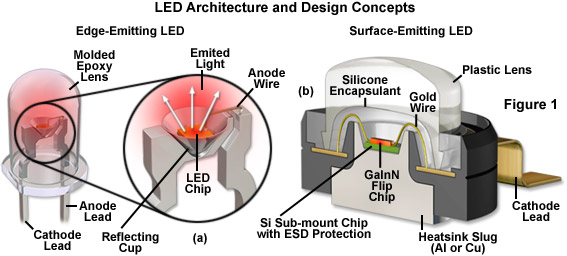


Figure 5

### Dc Motor

A DC motor relies on the fact that like magnet poles repel and unlike magnetic poles attract each other. A coil of wire with a current running through it generates an [electromagnetic](http://en.wikipedia.org/wiki/Electromagnetic) field aligned with the center of the coil. By switching the current on or off in a coil its magnetic field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°. A simple *DC motor* typically has a stationary set of magnets in the [stator](http://en.wikipedia.org/wiki/Stator) and an [armature](http://en.wikipedia.org/wiki/Armature_(electrical_engineering)) with a series of two or more windings of wire wrapped in insulated stack slots around iron pole pieces (called stack teeth) with the ends of the wires terminating on a [commutator](http://en.wikipedia.org/wiki/Commutator_(electric)). The armature includes the mounting bearings that keep it in the center of the motor and the power shaft of the motor and the commutator connections. The winding in the armature continues to loop all the way around the armature and uses either single or parallel conductors (wires), and can circle several times around the stack teeth. The total amount of current sent to the coil, the coil's size and what it's wrapped around dictate the strength of the electromagnetic field created. The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or [electromagnets](http://en.wikipedia.org/wiki/Electromagnet)) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor. At high power levels, DC motors are almost always cooled using forced air.

The [commutator](http://en.wikipedia.org/wiki/Commutator_(electric)) allows each armature coil to be activated in turn. The current in the coil is typically supplied via two brushes that make moving contact with the commutator. Now, some brushless DC motors have electronics that switch the DC current to each coil on and off and have no brushes to wear out or create sparks.

Different number of stator and armature fields as well as how they are connected provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature. The introduction of variable resistance in the armature circuit or field circuit allowed speed control of dc motors.

Since the series-wound DC motor develops its highest torque at low speed, it is often used in traction applications such as [electric locomotives, and trams](http://en.wikipedia.org/wiki/Railway_electrification_system). The DC motor was the mainstay of electric [traction drives](http://en.wikipedia.org/wiki/Traction_drive) on both electric and [diesel-electric locomotives](http://en.wikipedia.org/wiki/Diesel-electric_locomotive), street-cars/trams and diesel electric drilling rigs for many years. The introduction of DC motors and an [electrical grid](http://en.wikipedia.org/wiki/Electrical_grid) system to run machinery starting in the 1870s started a new [second Industrial Revolution](http://en.wikipedia.org/wiki/Second_Industrial_Revolution). DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles and today's [hybrid cars](http://en.wikipedia.org/wiki/Hybrid_car) and [electric cars](http://en.wikipedia.org/wiki/Electric_car) as well as driving a host of [cordless](http://en.wikipedia.org/wiki/Cordless) tools. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines.

If external power is applied to a DC motor it acts as a DC generator, a [dynamo](http://en.wikipedia.org/wiki/Dynamo). This feature is used to slow down and recharge batteries on[hybrid car](http://en.wikipedia.org/wiki/Hybrid_car) and electric cars or to return electricity back to the electric grid used on a street car or electric powered train line when they slow down. This process is called [regenerative braking](http://en.wikipedia.org/wiki/Regenerative_braking) on hybrid and electric cars. In diesel electric locomotives they also use their DC motors as generators to slow down but dissipate the energy in resistor stacks. Newer designs are adding large battery packs to recapture some of this energy.



Figure 6

Motor Information

Rated Voltage: 12 VDC  
Rated Speed:  50 RPM  
Rated Load:  60 Watts

An automotive battery is a type of [rechargeable battery](http://en.wikipedia.org/wiki/Rechargeable_battery) that supplies electric energy to an [automobile](http://en.wikipedia.org/wiki/Automobile).[[1]](http://en.wikipedia.org/wiki/Automotive_battery#cite_note-Bauer96-1) An automotive SLI battery (*starting, lighting, ignition*) powers the [starter motor](http://en.wikipedia.org/wiki/Starter_motor), the lights, and the [ignition system](http://en.wikipedia.org/wiki/Ignition_system) of a vehicle's [engine](http://en.wikipedia.org/wiki/Internal_combustion_engine).

Automotive SLI batteries are usually [lead-acid](http://en.wikipedia.org/wiki/Lead%E2%80%93acid_battery) type, and are made of six [galvanic cells](http://en.wikipedia.org/wiki/Galvanic_cell) in [series](http://en.wikipedia.org/wiki/Series_circuits) to provide a 12-[volt](http://en.wikipedia.org/wiki/Volt) system. Each cell provides 2.1 volts for a total of 12.6 volts at full charge. Heavy vehicles, such as highway trucks or tractors, often equipped with [diesel engines](http://en.wikipedia.org/wiki/Diesel_engine), may have two batteries in series for a 24-volt system or may have parallel strings of batteries.

Lead-acid batteries are made up of plates of [lead](http://en.wikipedia.org/wiki/Lead) and separate plates of [lead dioxide](http://en.wikipedia.org/wiki/Lead_dioxide), which are submerged into an[electrolyte](http://en.wikipedia.org/wiki/Electrolyte) solution of about 38% [sulfuric acid](http://en.wikipedia.org/wiki/Sulfuric_acid) and 62% [water](http://en.wikipedia.org/wiki/Water) This causes a [chemical reaction](http://en.wikipedia.org/wiki/Chemical_reaction) that releases [electrons](http://en.wikipedia.org/wiki/Electrons), allowing them to flow through [conductors](http://en.wikipedia.org/wiki/Electrical_conductor) to produce [electricity](http://en.wikipedia.org/wiki/Electricity). As the battery [discharges](http://en.wikipedia.org/wiki/Battery_capacity), the acid of the electrolyte reacts with the materials of the plates, changing their surface to [lead sulfate](http://en.wikipedia.org/wiki/Lead(II)_sulfate). When the battery is [recharged](http://en.wikipedia.org/wiki/Rechargeable_battery#Charging), the chemical reaction is reversed: the lead sulfate reforms into lead dioxide and lead. With the plates restored to their original condition, the process may now be repeated.

[Battery recycling](http://en.wikipedia.org/wiki/Battery_recycling) of automotive batteries reduces the need for resources required for manufacture of new batteries, diverts toxic lead from landfills, and prevents risk of improper disposal.



Figure 7

### Digital Voltmeter

This digital voltmeter circuit is a saving, easy to use Because it is smaller than a typical circuit, I believe that, after I presented this circuit. You will certainly like it.

This circuit can be used as Versatile. Features of the circuit :

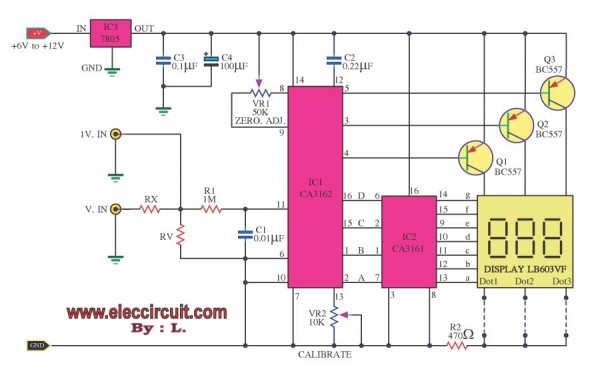
- 3-digit numeric display with LED 7 segment.  
- The maximum display +999 mV and the maximum negative-99mV.  
- Adjustment measurement range is not limited by the resistance, only two options.  
- Using the voltage + 5 V single power supply is not necessary to use the negative circuit pack.  
The heart in the working of circuit is IC CA3162E. Which converts analog signals into digital signals in a Dual – slope A / D conversion.  
The output of IC will be the multi-plex binarycode display type. so easy to build because has the wire to the display is a few.  
[](http://www.eleccircuit.com/wp-content/uploads/2012/07/3-digit-the-cheap-digital-voltmeter-using-ca3162-and-ca3161.jpg)

Figure 8

[](http://www.amazon.com/gp/product/B005UWD2J4/ref=as_li_ss_tl?ie=UTF8&camp=1789&creative=390957&creativeASIN=B005UWD2J4&linkCode=as2&tag=circuprojeele-20)

Figure 9

For the input signal we are divided into two ways to be:

First: 1V.IN for measure the DCVolt that has a voltage not exceeding 1volt.  
Second: But for those who want to measure the voltage higher than 1V. Enter the inputs into the Vi point, and change the Rx,Ry as you want.  
For example : you would like to the measure rang a maximum of 99.9 Volt you should use the value of Rx=10M, Ry=100K  
And in the the measure rang of 999V you should use the Rx=10M and Ry= 10K etc.  
OR …..

The Ry may be calculated from the formula:  
Ry = 10,000,000 /(Ei-1)  
When the Rx = 10M is fixed.  
Ei : is the measure rang as you want.  
C2 is a integrating Capacitor.

Parts Of The Circuit  
IC1\_\_\_\_\_\_\_\_\_\_\_\_\_\_CA3162E \_\_ A/D converter for 3-digit display  
IC2\_\_\_\_\_\_\_\_\_\_\_\_\_\_CA3161\_\_ BCD to Seven Segment Decoder-Driver  
Q1,Q2,Q3\_\_\_\_\_\_\_\_\_ BC548\_\_\_45V 100mA NPN Transistor  
R1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_1M\_\_\_1/4W Resistors  
R2\_\_\_\_\_\_\_\_\_\_\_\_\_\_470ohm\_\_ 1/4W Resistors  
Rx\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_see text  
Ry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_See text such as: 100K at 100V  
VR1\_\_\_\_\_\_\_\_\_\_\_\_\_\_50K\_\_\_Trimpot 18T

Wheels



Figure 10



Figure 11

Front wheels



Figure 12

Horn



Figure 13

Metal frame of the wheelchair



Figure 14

# BUILDING PROCESS

First we took off the orginal wheels of the wheelchair , then

we took out the orginal elevating leg rests and we welded new leg rests



Figure 15

**BUILDING PROCESS**

We welded new front legs that are smaller than orginal ones.



Figure 16

**BUILDING PROCESS**

We opened holes on the z shaped panel in order to place the motor on to the wheelchair.



Figure 17

**BUILDING PROCESS**

On the dc motor there is a metal frame and we placed it on the hard plastic rear tires.



Figure 18

**BUILDING PROCESS**

We coated our rear wheels with plastic layers in order to increase wheels’ durability and increase its diameter.



Figure 19

**BUILDING PROCESS**

We placed our coated wheels on the electric motor.



Figure 20

**BUILDING PROCESS**

We conncected our battery to our circuit (relays)



Figure 21

**BUILDING PROCESS**

We changed the connection type of our mouse from usb to phone cable (7mm) and connected it to our circuit.



Figure 22

# MOVEMENT MECHANISM

### Straight

As we said before our PC Mouse will contain two buttons.Chair will go straight if we push both buton.

When both buttons pushed each relays connected to each wheels become completed (smaller

ampere will cause magnetic field and this magnetic will pull metal part of relay and this metal part

will change its posittion) because of that main power from battery will directed from its source to

electrical wheels. Both electrical motor will start to work and each wheel start to turn.

### Turning Principle

Wheelchair will go left if we push the left buton when left buton is pushed right relay will connect right wheel (smaller ampere will cause magnetic field and this magnetic will pull metal part of relay and this metal part will change its position) because of that main power from battery will directed from its source to electrical wheels. Right electrical motor will work.While leff wheel won’t turn when right wheel turns our wheel chair will turn left.

**MOVEMENT MECHANISM**

### Stopping Principle

When there is no electic given the motors will not move since they have a gearmechanism.

Design Of The Circuit

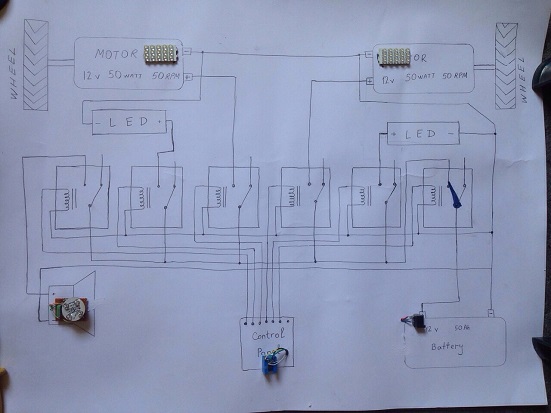


Figure 23

# DIFFUCULTIES DURING CONSTRUCTION

****

Major difficulty was welding because non of us had any experience with welding machine.

Figure 24

Finding correct parts was another difficulty for us, we had to buy them from Turkey.

Coating the rear wheels was another difficulty we couldn’t find any ready tire casing so we found a motorcycle tires and cut it in to the pieces and just used the middle part of it.

# ADVANTAGES

You can fold it easly just by removing battery.

Using mouse as controller : minimizing the patients’ hand movement (just using 2 finger will be enough.)

You can easily remove electric motors if there is a problem.(They are not hidden under the metal frame.)

It is very light when you compare it with other wheelchairs.

# DISADVANTAGES

There is no alarm system for battery life.

We didn’t weld our motors on main metal frame,we welded them on a thin metal plate.So if there is too much weight metal plate can fold to a wider angle.

It is not comfortable as other wheelchairs,since we used a limited budget .

With these parts it can not go backwards.

# CURRENT DEVICES

Cirrus Plus HD Compact Mid-Wheel



Figure 25 Figure 26

Compass SportMedalist P22



Figure 27 Figure 28

**CURRENT DEVICES**

Pride Go-Chair TravelPride Jazzy 600



Figure 29 Figure 30

Pride Jazzy Elite HDPronto M51



Figure 31 Figure 32

**CURRENT DEVICES**

Quickie Xtender Power AssistZip'r PC



Figure 33 Figure 34

# FUTURE IMPROVEMENTS

Adding backward movement**.**

Building it more higher off the ground .

We can use bigger tires which means using stronger motors .

We can add a mechanism that will raise the seat.

We can add ultrasound sensors around the wheelchair that will warn us if there is an obstacle.

We can add suspension to wheels in order to improve durability of wheelchair.

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<http://en.wikipedia.org/wiki/Mouse_%28computing%29>

<http://en.wikipedia.org/wiki/Direct_current>

<http://en.wikipedia.org/wiki/Diode>

<http://en.wikipedia.org/wiki/Relay>

**APPENDIX**

* Suspension is the system of [springs](http://en.wikipedia.org/wiki/Spring_(device)), [shock absorbers](http://en.wikipedia.org/wiki/Shock_absorber) and [linkages](http://en.wikipedia.org/wiki/Linkage_(mechanical)) that connects a [vehicle](http://en.wikipedia.org/wiki/Vehicle) to its [wheels](http://en.wikipedia.org/wiki/Wheel) and allows relative motion between the two.
* Four Wheel Drive is a transmission system which provides power directly to all four wheels of a vehicle.
* Relay  is an [electrically](http://en.wikipedia.org/wiki/Electric) operated [switch](http://en.wikipedia.org/wiki/Switch). Many relays use an [electromagnet](http://en.wikipedia.org/wiki/Electromagnet) to mechanically operate a switch, but other operating principles are also used, such as [solid-state relays](http://en.wikipedia.org/wiki/Solid-state_relay).
* LED is a light-emitting diode (LED) is a two-lead [semiconductor](http://en.wikipedia.org/wiki/Semiconductor) [light source](http://en.wikipedia.org/wiki/Light_source).
* Diode is a two-[terminal](http://en.wikipedia.org/wiki/Terminal_(electronics)) [electronic component](http://en.wikipedia.org/wiki/Electronic_component) with asymmetric [conductance](http://en.wikipedia.org/wiki/Electrical_conductance); it has low (ideally zero) [resistance](http://en.wikipedia.org/wiki/Electrical_resistance_and_conductance) to [current](http://en.wikipedia.org/wiki/Electric_current) in one direction, and high (ideally [infinite](http://en.wikipedia.org/wiki/Infinity)) resistance in the other.
* DC Motor relies on the fact that like magnet poles repel and unlike magnetic poles attract each other. A coil of wire with a current running through it generates an [electromagnetic](http://en.wikipedia.org/wiki/Electromagnetic) field aligned with the center of the coil. By switching the current on or off in a coil its magnetic field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°.
* Voltmeter  is an instrument used for measuring [electrical potential](http://en.wikipedia.org/wiki/Electrical_potential) difference between two points in an electric circuit.
* Astable Multi Vibrator is an [electronic circuit](http://en.wikipedia.org/wiki/Electronic_circuit) used to implement a variety of simple two-state systems such as [oscillators](http://en.wikipedia.org/wiki/Electronic_oscillator), [timers](http://en.wikipedia.org/wiki/Timer) and [flip-flops](http://en.wikipedia.org/wiki/Flip-flop_(electronics)).
* Wheel is a circular component that is intended to rotate on an axial [bearing](http://en.wikipedia.org/wiki/Bearing_(mechanical)).
* Magnetic Field is the magnetic influence of [electric currents](http://en.wikipedia.org/wiki/Electric_current) and [magnetic materials](http://en.wikipedia.org/wiki/Magnet).
* Voltage  is the [electric energy charge](http://en.wikipedia.org/wiki/Electric_charge) difference of [electric potential energy](http://en.wikipedia.org/wiki/Electric_potential_energy) transported between two points.
* Direct current (DC) is the unidirectional flow of [electric charge](http://en.wikipedia.org/wiki/Electric_charge).
* Capacitor (originally known as a condenser) is a [passive](http://en.wikipedia.org/wiki/Passivity_(engineering)) [two-terminal](http://en.wikipedia.org/wiki/Terminal_(electronics)) [electrical component](http://en.wikipedia.org/wiki/Electronic_component) used to store [energy](http://en.wikipedia.org/wiki/Energy) [electrostatically](http://en.wikipedia.org/wiki/Electrostatic) in an [electric field](http://en.wikipedia.org/wiki/Electric_field).
* Mouse (PC) In [computing](http://en.wikipedia.org/wiki/Computing), a mouse is a [pointing device](http://en.wikipedia.org/wiki/Pointing_device) that detects [two-dimensional](http://en.wikipedia.org/wiki/Two-dimensional_space) motion relative to a surface.