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Fabrication of Voice Operated Intelligent Wheelchair

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INTRODUCTION

Intelligent wheelchair will play an important role in the future welfare society. The use of intelligent wheelchair encourages the view of the machine as a partner rather than as a tool. The population of people with disabilities has risen markedly during the past century. As the data come from the National Health Interview Survey (NHIS), two distinct trends have contributed to the increasing overall prevalence of disability: a gradual rise, due largely to demographic shifts associated with an aging population, as well as a rapid increase that is due to health impairments and accidents. Many individuals have problems to use a conventional wheelchair. A recent clinical survey indicated that 9%-10% of patients who received power wheelchair training found it extremely difficult or impossible to use it for their activities of daily living, and 40% of patients found the steering and manoeuvring tasks difficult or impossible. These people, suffering from motor deficits, disorientation, amnesia, or cognitive deficits, are dependent upon others to push them, so often feel powerless and out of control. Intelligent wheelchair has the potential to provide these people with effective ways to alleviate the impact of their limitations, by compensating for their specific impairments. Robotic wheelchairs may help in manoeuvring a wheelchair and planning motion. Recently, research of assistant robots is also emerging field of robotic applications.

In our project, we are making a speech recognition based wheel chair for patients. The patients who cannot walk and have to use a wheel chair can navigate the wheel chair by their voice. While the needs of many individuals with disabilities can be satisfied with power wheelchairs, some members of the disabled community find it is difficult or impossible to operate a standard power wheelchair. This project could be part of an assistive technology. It is for more independent, productive and enjoyable living.

PROJECT BACKGROUND

The idea of using voice activated technology for controlling the motion of the wheelchair is to prove that it can be a unique concept that would stand apart from the rest of the average projects. The use of this new technology in conjunction with a mechanical system to simplify everyday life would spark interest in an ever-growing modern society. Many people with disabilities do not have the dexterity necessary to control a joystick on anelectrical wheelchair. This can be a great for the quadriplegics who is permanently unable to move any of the arms or legs. They can use their wheelchair easier only using voice commands.

The aim of this study is to implement an interesting application using small vocabulary word recognition system. The methodology adopted is based on grouping a microprocessor with a speech recognition development kit for isolated word from a dependent speaker. The resulting design is used to control a wheelchair for a handicapped person based on the vocal command. It therefore involves the recognition of isolated words from a limited vocabulary. To gain in time design, tests have shown that it would be better to choose a speech recognition kit and to adapt it to the application. There are five options for basic motions of a wheelchair to be applied by the user.

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The five conditions of the wheelchair can be described as the following:

- Moving forward to the front of the user
- Turning to the right
- Turning to the left
- Static or stop condition

This Project describes the design and development of the motion control using voice recognition for a wheelchair application. The current power wheelchair control interfaces used may not, be adequate to provide truly independent mobility for substantial number of person with disabilities. The Respondents to the survey reported on average that approximately ten percent of the patients trained to operate a power wheelchair cannot use the chair upon completion of training for activities of daily living or can do so only with extreme difficulty (Linda Fehr, 2000).

OBJECTIVE

- To develop a voice interface system for wheelchair control.
- To provide an extra alternative to the wheelchair users so that this can increase the ease of mobility for severely disabled/injured people.
- To implement the voice user as an input to control the movement of wheelchair
- Provide the facilities for the disabled people and elderly people who cannot move properly.

METHODOLGY

To make this project successful, there are several methodologies have been carried out. After doing the literature survey, development and testing have been done. In order to achieve the objectives right methodologies have been chosen for it. The correct flow will make the work become systematic and easy. The literature survey is very useful for the future development of the project. In literature survey part, previous work by different researchers are analysed and compared. There is also needed to study on the actual product for developing and modifying on the project.

PROBLEM STATEMENT

A handicapped person with locomotive disabilities needs a wheelchair to perform functions that require him or her to move around. He can do so manually by pushing the wheelchair with his hands. However, many individuals have weak upper limbs or find the manual mode of operating too tiring. Hence it is desirable to provide them with a motorized wheelchair that can be controlled by moving a joystick or through voice commands. Since the motorized wheelchair can move at a fair speed, it. All this should be achieved at a cost that is affordable for as many handicapped people as possible, as well as for organizations that support them.

The power wheelchair control interfaces currently still not enough to provide truly independent mobility for substantial number of person with disabilities. The power wheelchair to control development along safe and effective use of the provision independence and self-use mobility. This project will provide disability weight innovative solutions to handle the wheel chairs to use voice interface. This project describes a wheelchair which can be controlled only by using the user's voice. This project aims to facilitate the movement of the disabled people and elderly people who cannot move properly then enable them to lead better lives without any problem. Speech recognition technology is a key technology which can provide a new way of human interaction with machines or tools for controlling a wheelchair. This project consists of two parts which is software and hardware. It is realizedby using the microphone as an intermediary which is used as the input of human voice. In this project, Programmable Integrated Circuit is used as a switch to control the movement of wheelchair based on the human voice as an input with installing two DC motor as the driving force.

There are five options for basic motions of a wheelchair to be applied by the user. The five conditions of the wheelchair can be described as the following:

- Moving forward
- Turning to the right
- Turning to the left
- Stop condition

This project describes the design and development of the motion control using voice recognition for a wheelchair application.

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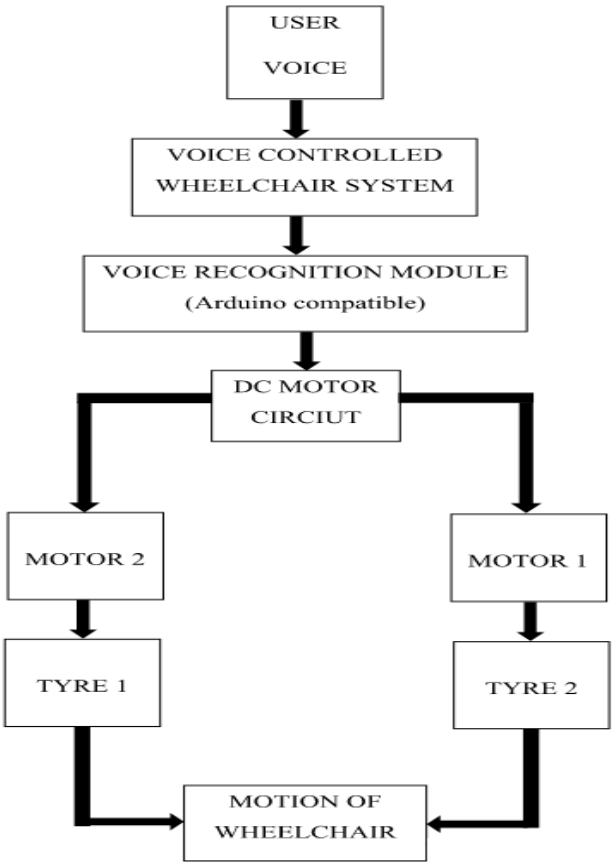
WHEELCHAIR OPERATION

When the voice is detected, the wheelchair can be controlled to move in that direction by giving commands to the wheelchair. These commands are transferred to the wheelchair using electrical signals which are used the drive the left or right motor of the wheelchair. There are basically two motors connected to the left and right wheels of the wheelchair. The electrical signals are transferred to these motors using some hardware ports, called the communication ports. Generally, the communication port is the parallel port. There are some basic predefined pins of this parallel port which accept the commands given to the wheelchair in the form of electrical signals. Four wheels are used in the wheelchair for proper balancing. The movement of wheels is controlled by DC motors which are attached to the wheelchair. Two wheels located on left side of the wheelchair are controlled by one motor and similarly the wheels on the right side are controlled by the second motor.

METHODOLOGY



Table(1) List of wheelchair components

SL NO.	ITEMS
1	WHEEL (22 INCH) - 2 NOS
2	WHEEL (6 INCH) - 2 NOS
3	FRAME (Mild steel)
4	DC MOTOR (12v, 24WATT) - 2 NOS
5	BATTERY (12V) - 1 NOS (6V) - 2 NOS
6	VOICE RECOGNITION MODULE (Arduino Compatible)
7	Relay Switch (DC 12v, 100 OHMS)

WHEELCHAIR COMPONENTS

Wheels

Wheelchair has four wheels, two rear wheels and two castor wheels, the two-caster wheel are fixated in wheelchair base in front all wheels have the same diameter. The drive wheels are in rear on either side of the base, allowing the chair to turn according to voice command, wheels engage directly to a gear train that transmit torque form motor to wheels by two grooves in each wheel and nut.

Motors

Motors come in many shapes and sizes. There are electromagnetic direct current (DC) motors and electromagnetic alternating current (AC) motors and many variations of each. AC motors are typically used for large applications, such as machine tools, washers, dryers, etc., and are powered by an AC power line. Since the typical power supply for mobile robotic is a DC battery, and technology for transforming DC to AC is very expensive in both terms of monetary cost and power cost, AC motors where ruled out as an option for the robot. DC motors are commonly used for small jobs and suited the purposes of the platform very well. D.C. motors are of great industrial importance. The main advantage of a D C motor is that it is amenable to different methods of speed control to provide a wide range of speeds and good speeds regulation. A machine that converts D C power into mechanical power is called a D C motor.

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Working:

A D C motor works on the principle that "whenever a current carrying conductor is placed in a magnetic field, it experiences a force and tends to move at right angles to the direction of flux. The direction of rotation of the conductor is determined by Fleming's left-handrule.

The magnitude of the force experienced by the conductor is given by the equation,

$F = B * I * L$ [Newton]

Where,

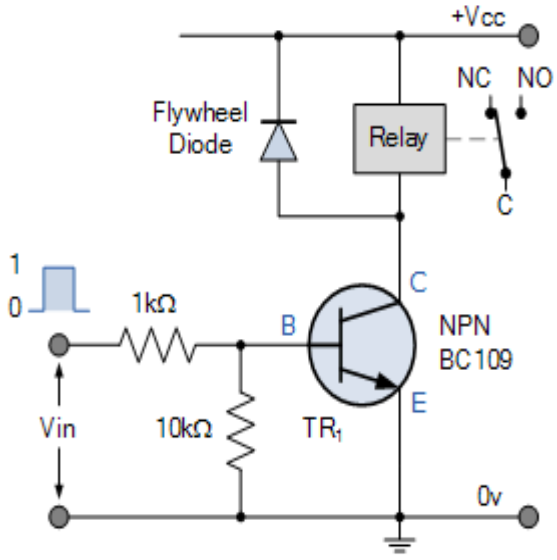
B = flux density. [Tesla]

I = current in the conductor. [Amperes]

L = length of the conductor. [Meters]

Figure (1) DC motor (12v 24watt) used in wheelchair

Relay Switch



Figure(2) Circuit Diagram

Figure(3) Relay Switch (DC 12v-100 OHMS)

A relay can be defined as a switch. Switches are generally used to close or open the circuit manually. Relay is also a switch that connects or disconnects two circuits. But instead of manual operation a relay is applied with electrical signal, which in turn connects or disconnects another circuit. Relays can be of different types like electromechanical, solid state. Electromechanical relays are frequently used. Let us see the internal parts of this relay before knowing about it working. Although many different types of relay were present, their working is same.Every electromechanical relay consists of a

- Electromagnet
- Mechanically movable contact
- Switching points and
- Spring

Electromagnet is constructed by wounding a copper coil on a metal core. The two ends of the coil are connected to two pins of the relay as shown. These two are used as DC supply pins. Generally, two more contacts will be present, called as switching points to connect high ampere load. Another contact called common contact is present in order to connect the switching points.Relay can be operated using either AC or DC.In case of AC relays, for every current zero position, the relay coil gets demagnetized and hence there would be a chance of continues breaking of the circuit.So, AC relays are constructed with special mechanism such that continues magnetism is provided in order to avoid above problem. Such mechanisms include electronic circuit arrangement or shaded coil mechanism.

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Working:

Relay works on the principle of electromagnetic induction.

When the electromagnet is applied with some current it induces a magnetic field around it.

Above image shows working of the relay. A switch is used to apply DC current to the load.

In the relay Copper coil and the iron core acts as electromagnet.

When the coil is applied with DC current it starts attracting the contact as shown. This is called energizing of relay.

When the supply is removed it retrieves back to the original position. This is called De energizing of relay.

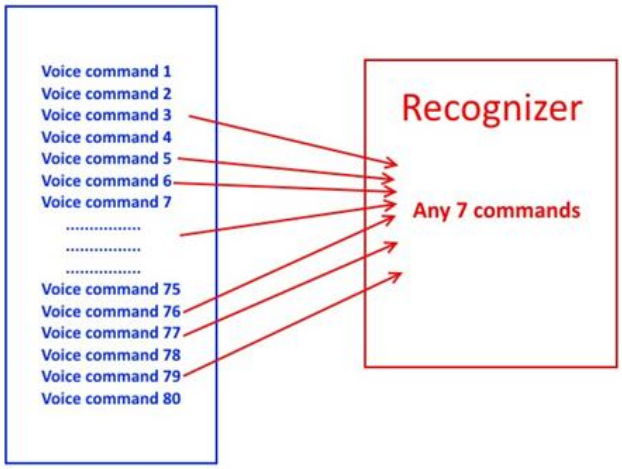
There are also such relays, whose contacts are initially closed and opened when there is supply i.e. exactly to opposite to the above shown relay.

Solid state relays will have sensing element to sense the input voltage and switches the output using opto-coupling.

Voice Recognition Module (Arduino compatible)

Figure(4) Voice Recognition Module (Arduino Compatible)

Voice Recognition Module is a compact and easy-control speaking recognition board.This product is a speaker-dependent voice recognition module. It supports up to 80 voice commands in all.Max 7 voice commands could work at the same time. Any sound could be trained as command. Users needto train the module first before letting it recognize any voice command.This board has 2 controlling ways: Serial Port (full function), General Input Pins (part of function). GeneralOutput Pins on the board could generate several kinds of waves while corresponding voice command was recognized.voice commands are stored in one large group like a library. Any 7 voice commands in the librarycould be imported into recognizer. It means 7 commands are effective at the same time.



Figure(5) Voice Command Recognizer

Microcontroller (Atmel Atmega328p)

A microcontroller is a small computer on a single integrated circuit. In modern terminology, it is a system or SoC. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal or other general-purpose applications consisting of various discrete chips.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes.

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Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Figure (6) Microcontroller (Atmel Atmega328p) and Specification

The Atmega328 is a very popular microcontroller chip produced by Atmel. It is an 8-bit microcontroller that has 32K of flash memory, 1K of EEPROM, and 2K of internal SRAM.The Atmega328 is one of the microcontroller chips that are used with the popular Arduino boards. The Arduino board comes with either 1 of 2 microcontroller chips, the Atmega168 or the Atmega328. Of these 2, the Atmega328 is the upgraded, more advanced chip. The Atmega328 has 32K of flash program memory and 2K of Internal SRAM.

The Atmega328 has 28 pins. It has 14 digital I/O pins, of which 6 can be used as PWM outputs and 6 analogue input pins. These I/O pins account for 20 of the pins.

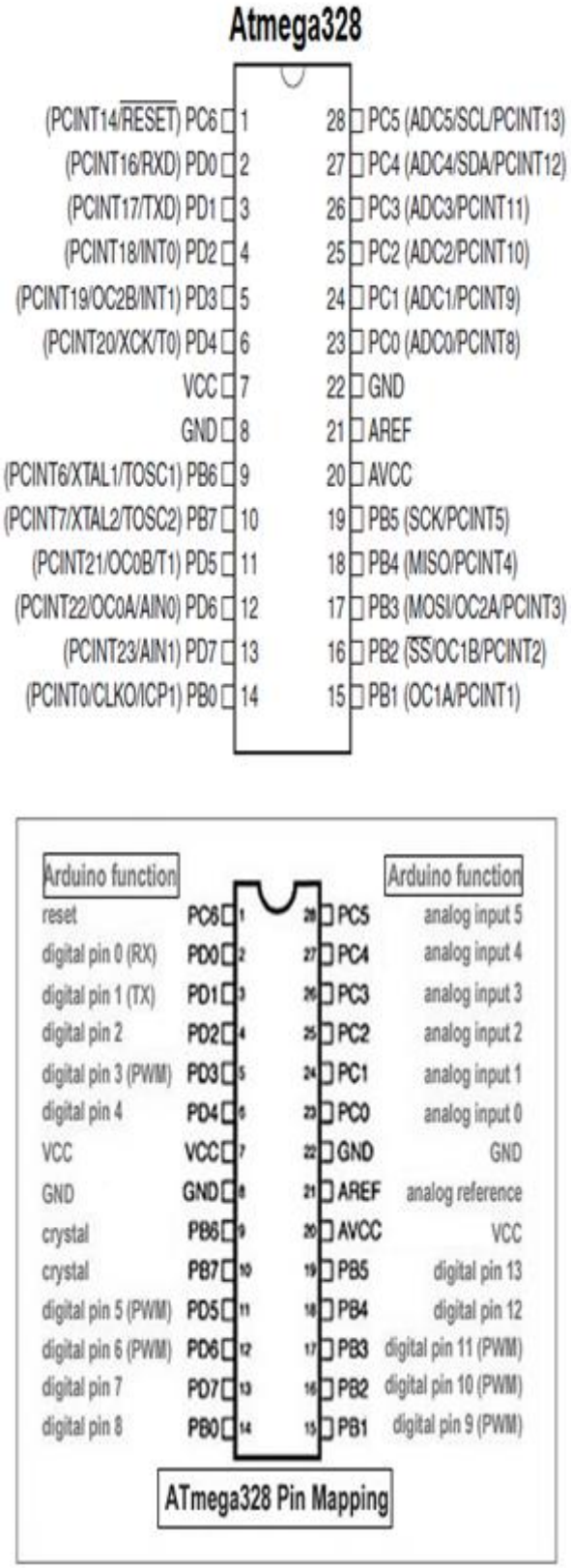

Figure (7) Pin mapping for the Atmega328

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As stated before, 20 of the pins function as I/O ports. This means they can function as an input to the circuit or as output. Whether they are input or output is set in the software. 14 of the pins are digital pins, of which 6 can function to give PWM output. 6 of the pins are for analog input/output.2 of the pins are for the crystal oscillator. This is to provide a clock pulse for the Atmega chip. A clock pulse is needed for synchronization so that communication can occur in synchrony between the Atmega chip and a device that it is connected to.The chip needs power so 2 of the pins, Vcc and GND, provide it power so that it can operate. The Atmega328 is a low-power chip, so it only needs between 1.8-5.5V of power to operate.

The Atmega328 chip has an analog-to-digital converter (ADC) inside of it. This must be or else the Atmega328 wouldn't be capable of interpreting analog signals.

Because there is an ADC, the chip can interpret analog input, which is why the chip has 6 pins for analog input. The ADC has 3 pins set aside for it to function- AVCC, AREF, and GND. AVCC is the power supply, positive voltage, that for the ADC. The ADC needs its own power supply in order to work. GND is the power supply ground. AREF is the reference voltage that the ADC uses to convert an analog signal to its corresponding digital value. Analog voltages higher than the reference voltage will be assigned to a digital value of 1, while analog voltages below the reference voltage will be assigned the digital value of 0. Since the ADC for the Atmega328 is a 10-bit ADC, meaning it produces a 10-bit digital value, it converts an analog signal to its digital value, with the AREF value being a reference for which digital values are high or low.

Thus, a portrait of an analog signal is shown by this digital value; thus, it is its digital correspondent value.The last pin is the RESET pin. This allows a program to be rerun and start over.And this sums up the pinout of an Atmega328 chip.

RESULT AND CALCULATIONS

After the fabrication, some testing and analysis are done. This includes testing on the accuracy of the system and wheelchair velocity.

Accuracy of Speech Recognition Circuit:

Experiment purpose is to find out the accuracy of the speech recognition circuit in different conditions.
The voice recognition system will be first tested in a quiet room with a single user. All words were correctly recognized.
Next, we will test it with a different user on whom the system was not trained. About 5% errors occurred in this case. This was because the recognizer heard a different pronunciation.
Next, we tested the system in a noisy room by turning on some music in that room. When the music was light there was no problem in correctly recognizing the words but when we turned then volume high the recognizer found it difficult to recognize the user's voice.

To Find the Velocity of Wheelchair:

The experiment conducted by using the ruler and time watch. Voice controlled wheelchair moved in a straight line then the distance and time was taken.There are two conditions of velocity need to take in the experiment.
1) Velocity of the unload condition. The wheelchair will let it go in a straight line and the result was taken:
Weight of the wheelchair in unload condition = 30kg
Distance was taken = 2m

Time taken:

Trial No.	Time (s)
1	3.56
2	3.71
3	3.49
Average	3.58

$$\text{Velocity} = \frac{Distance}{Time} = \frac{2}{3.58} = 0.56\,m/s$$

2) Velocity of the load condition.The wheelchair will let it go in a straight line and the result was taken:
Weight of the wheelchair in unload condition = 30kg
Weight of the person who sat on the wheelchair = 50kg
Distance was taken = 2m
Time taken = 6.5s

$$\text{Velocity} = \frac{Distance}{Time} = \frac{2}{6.4} = 0.31\,m/s$$

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Based on the result above, the velocity of voice controlled wheelchair is affected by the load. That's mean the velocity of wheelchair system will decrease proportional to the load that is carry by the system.

D C Motor Calculation:

Speed: 100 rpm
Power: 24.6 watt

$$\text{Power} = \frac{2\pi NT}{60}(\text{watt})$$

$$24.6 = \frac{2\pi * 100 * T}{60}$$

$$\text{Torque}(T) = \frac{24.6}{2\pi * 100} * 60 = 2.34\ Nm$$

Figure (8) Voice operated intelligent wheelchair (Front view)

Figure (9) Voice operated intelligent wheelchair (Side view)

CONCLUSION

The speed and direction of the wheelchair can be selected using the specified commands.The only thing needed to ride the wheelchair is to have voice. The design not only reduce the manufacture cost compare with present market one but also will give great competitive with other types of electrical wheelchair. However there are some improvements should be done to make it more reliable. This is outlined in the recommendation part. By improving this system, we directly enhance the life style of the disable people in the community. We have successfully designed and implemented a motorized wheelchair controlled voice recognition. The voice recognition system worked for most of the commands (over 95%). Only when a word was not properly vocalized, the system did not recognize it.

SCOPE AND FUTURE WORK

Develop the voice recognition system by using Voice recognition module. Voice recognition issues a command to control the movement of wheelchair. Microcontroller and DC motor circuit were built for movement of wheelchair. This system works in a quiet environment so that no disorder during recognize the user voice. Furthermore, the user voice must clear in short distance on microphone to ensure the accuracy of the pronunciations of the word-related (voice) was essential in this innovation. The Obstacle avoidance sensors can be interfaced. Home appliance control circuit can interfaced along with wheel chair control.

Adding the signal conditioning part which is consisting of a filter circuit. In signal processing, the function of a filter is to remove unwanted parts of the signal, such as random noise, or to extract useful parts of the signal, such as the components lying within a certain frequency range. To apply sensors for security purpose. There so many types of sensors are available. However, many researches and testing with different algorithms have to be done in order to make it successful. Designing a controller to control the front wheels so that they will be self-centred each time the wheelchair stops. Lastly, the circuit to control the motor can be replaced by a microcontroller for example peripheral interface controller (PIC). By using the microcontroller the speed

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and direction of the wheelchair can be controlled and performed better. So, the speed can be varied simultaneously without stopping the movement of the wheelchair.

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