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Automatic wheelchair cum bed with voice control movement for paraplegic patients

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Abstract:

Automatic wheelchair cum bed with voice control mechanism for paraplegic patients is an innovative idea in the field of rehabilitation. For precise control and accurate movements, the joystick and voice control mechanisms are used by the patients. Voice controlled movement will be extremely helpful to someone who might lack the physical ability to move both their legs. The wheelchair can also be customized as a bed by stretching it. This will help the paraplegic patient to lie down without an auxiliary support. The hardware set up will provide the necessary mechanical movements like forward, left, right and height. By means of ultrasound sensor, the obstacle can be detected and displayed on the LCD. The patients with paraplegia find it very difficult to sit continuously in the same position as it can develop back pain and muscle cramps. Thus as a preventive measure, a massaging system for the lumbar region is incorporated in this wheelchair.

Keywords — **Wheel chair, Joy stick, paraplegia**

I. INTRODUCTION

A wheelchair is a chair with wheels, designed to be a replacement for walking. The device comes in variations where it is propelled by motors or by the seated occupant turning the rear wheels by hand. Often there are handles behind the seat for someone else to do the pushing. Wheelchairs are used by people for whom walking is difficult or impossible due to illness (physiological or physical), injury, or disability. People with both sitting and walking disability often need to use a wheel bench.

II. EXISTING METHODS

A basic manual wheelchair incorporates a seat, foot rests and four wheels: two, caster wheels at the front and two large wheels at the back. The two larger wheels in the back usually have hand rims; two metal or plastic circles approximately 3/4" thick. The hand rims have a diameter on average slightly smaller than the wheels they are attached to. Most wheelchairs have two push handles at the top of the back to allow for manual propulsion by a second person.

Other varieties of wheelchair differs only in their basic design, but can be customized for the user needs. Such customizations may encompass the seat dimensions, height, seat angle footrests, leg rests, front caster outriggers, adjustable backrests and controls.

A. Manually Propelled

Manual wheel chair requires human power to move them and can be folded for storage. These wheelchairs are propelled by the occupant, usually by turning the large rear wheels, from 20-24 inches (51–61 cm) in average diameter, and resembling bicycle wheels. Skilled users can control turning speed and often learn to balance the chair on its rear wheels. Thus the rear wheel can control the chair while climbing, descending and moving over an obstacle.

Foot propulsion of the wheelchair is common for patients having limited hand movement. Foot propulsion allows patients to exercise their legs to

increase blood flow and limit further disability. Attendant-propelled chairs otherwise called as transport wheelchairs, are designed in such a way that it can be propelled by an attendant using the handles. These chairs are often used to move a patient possibly within a hospital, as a temporary option.

III. METHODOLOGY

The device consists of an embedded microcontroller which acts as a brain of the system and controls the sensor, switch, joystick and microphone. It processes the commands based on how it is pre-programmed and makes appropriate decisions.

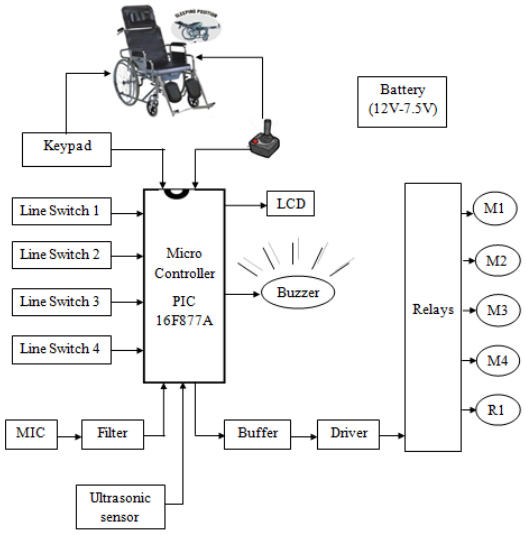

Fig.1 Block Diagram

The whole system drives power from a rechargeable battery of 12V with a current rating of 7 Ampere-hour. The system contains relays which will control the motion of motors through which the wheel chair will be controlled as well. The motors used are Forward Motor (M1), Left Motor (M2), Right Motor (M3), Height adjusting Motor (M4), Roller Motor (R1). The roller motor functions to give the massaging effect in the device. The operation of the wheelchair can be controlled by two mechanisms, either through joystick or through voice control. Keypad is used for selecting the operation to be performed in the wheelchair. And through the microphone, the patient can give instructions for the movement. The obstacles in the path of motion can be detected using the ultrasonic sensor which is placed in the foot rest portion and warning signal can be indicated through the buzzer. An additional feature of display unit is incorporated to indicate the low battery power and the distance at which the obstacle is present.

A. PIC Microcontroller

PIC (Programmable Interface Controller) consist of electronic circuits that can be programmed to do various kind of functions like timers and controllers. It is a family of microcontrollers made by microchip technology. The earlier models of PIC microcontroller had read-only memory (ROM) or field-programmable EPROM for program storage and few models with provision for erasing memory. Current models of PIC use flash memory for program storage.

B. Buzzer

A buzzer or beeper is a device, usually electronic, mechanical, electromechanical and piezoelectric type used for audio signaling. The buzzing sound can be either continuous or intermittent. It is connected in the circuit end through sensor, timers and switches connected to a control unit. The conventional model of this device was designed based on an electromechanical system which was similar to an electric bell without the metal gong (which makes the ringing noise).

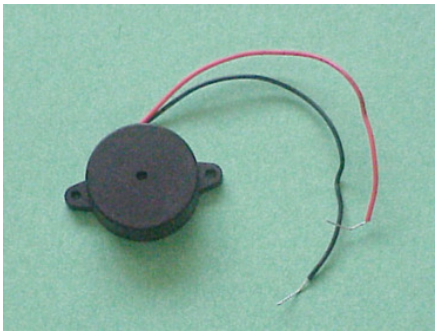

Fig.2 Buzzer

Currently, the use of ceramic-based piezoelectric sounder was popular because of its high-pitched tone. The wide applications of buzzer include novelty, judging panels, electronic circuits,

home appliances, educational purposes, alarming system for security and many more in our day to day life.

C. DC Motor

DC motor is a device which transforms the electrical energy in to mechanical energy by the application of DC power as energy source. It contains a current carrying armature which is connected to the supply end through the segments of the armature and brushes. The armature is placed in between the two poles of the electromagnet. To determine the direction of force acting on the armature conductors of DC motor, the Flemings left hand rule is applied. The current carrying conductor experiences a force, if it is placed in a magnetic field perpendicularly. The direction of force is mutually perpendicular to both the direction of field and the current carrying conductor.

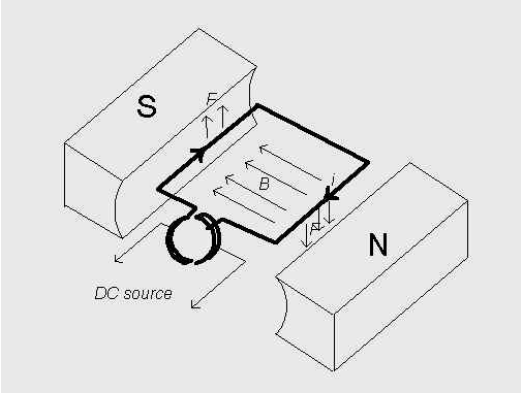

Fig.3 Principle of DC motor

D. Liquid Crystal Display

Liquid crystal display (LCD) is a flat panel display unit which uses the properties of light modulating crystals. It is also called as electronically modulated optical device. It uses the backlight or reflector to produce images in color or monochrome instead of emitting the light directly. It is composed of several layers of polarized panel filters and electrodes. The principle of operation of LCD is, when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. Due to this, there is a change in the angle of light passing through the molecule of the polarized glass and also cause a change in the angle of the top polarizing filter. This results in a fine light that is allowed to pass the polarized glass through a particular area of the LCD. As a consequence, that particular area will become dark compared to other. The major benefits of using LCD for display include power consumption when compared to CRT or LED, low cost and excellent contrast. And this technology has major applications in the field of science and engineering, electronics and medical applications. In this paper, the LCD is incorporated to display the presence of obstacle and low battery indication.

Fig.4 Liquid Crystal Display

E. Battery Cells

Battery is a container that includes one or more cells, in which chemical energy is converted into electricity and used as a power source. Battery cells are the basic individual component of a battery consisting of two electrodes, anode and cathode and are connected by electrolytes.

1. Lead acid battery

A lead-acid battery is a device used to store electrical charge. It is a combination of lead plates or grids and an electrolyte consisting of a diluted sulphuric acid to convert electrical energy into potential chemical energy and back again. The electrolyte used in lead-acid battery is harmful and may produce burns and other permanent damage if you come into contact with it. Lead-acid cell fluctuates in voltage ranging from about 2.12 V when full to about 1.75 V when empty.

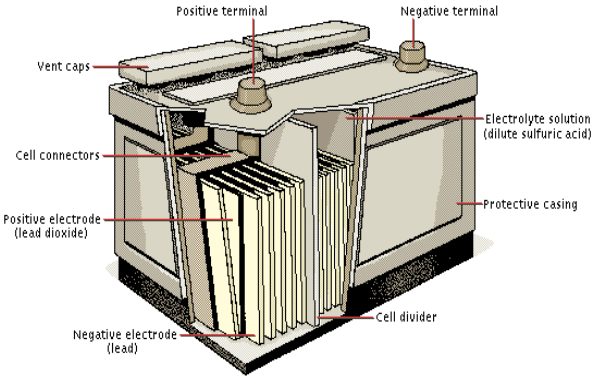

Fig .5 Lead Acid Battery

F. Relay

A relay can be used as a switch when an electrical supply is provided. Most of the relays use an electromagnet to operate the switch

mechanically. It consists of a coil of wire surrounded around the soft iron core. When an coil is energized by an electric current, it generates a magnetic field that activates the armature. This result in the movement of the movable contact(s) either makes or breaks (depending upon construction) a connection with a fixed contact. When the relay was de-energized during the set of contacts was closed, and then the movement opens the contacts and breaks the connection, and vice versa if the contacts were opens. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position.

G. Microphone

A microphone is a transducer that is used to convert sound into electrical signals i.e., they produce a voltage or a current which is proportional to the sound signal. The most commonly used microphones are dynamic, ribbon, or condenser microphones. Microphones can be designed with different directional patterns and different impedances.

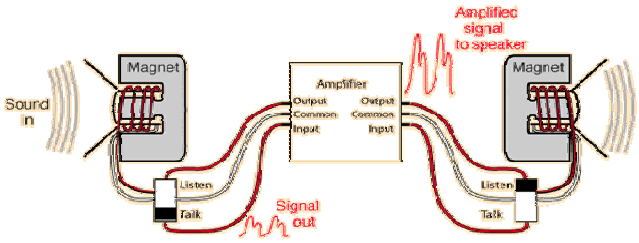

Fig.6 Simple intercom of loudspeaker

A small loudspeaker can be used as a dynamic microphone, and this fact is subjugated in the construction of small intercom systems. Depending on the position of the Talk-Listen switch, the device on either end of the intercom system can be used as a microphone or a loudspeaker. Of course, this is not a high fidelity process, and for commercial dynamic microphones, the device is optimized for use as a microphone, not a loudspeaker.

IV. MECHANICAL DESIGN

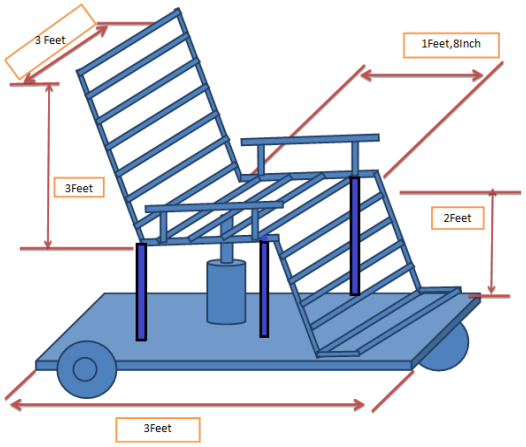

Fig .7 Mechanical Design

The Automatic wheelchair is designed to perform various special functions which provide rehabilitation scopes to the user together with providing stable and smooth motion in normal or slightly inclined surfaces. There are various mechanisms used to incorporate the required functions. Functional motors along with these mechanisms work together to realize the requirements. The conversion mechanism uses a spring mechanism and pivot arrangement. Whereas the height adjustment mechanism is actuated using a screw jack. The overall structural design of the wheelchair is done in an ergonomic manner, taking into consideration the standard human size. The length and width of the wheelchair is in proportion to the normalized values of height and width of males and females according to Anthropometric data. The design is done in such a manner that the wheelchair can be used for all kinds of purpose.

V. CONCLUSION AND FUTURE SCOPE

The developed project "Automatic wheelchair cum bed with voice control mechanism for paraplegic patients" helps to improve the capabilities of a paraplegic to become more independent. It was designed with the facilities of

bed conversion, height adjustment, massaging provision and voice control mechanism for

movements. The bed conversion mechanism reduces the strain developed at the back of patient. The height adjustment mechanism helps the person to adjust the height of the wheelchair according to the patients need. The massaging mechanism helps to prevent the bed sores formation and reduces the chances for back sprain. The voice control mechanism allows the chair to move in accordance with the commands given by the patient. The output was obtained in successful manner.

The present product can be further enhanced with certain additional features. Currently the system can be used in only flat or slightly inclined surfaces and does not have a staircase climbing mechanism. So by incorporating an efficient conveyor belt wheel drive mechanism, the system can be used for staircase climbing. A magneto therapy to the legs of a paraplegic wheelchair user can also be incorporated for improving the blood circulation in the legs. Further, the current system consisting mainly of motors for screw jack system for height adjustment can be replaced with a hydraulic system which increases the efficiency of the product.

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