ADHAR – The Hope For The Disabled People Of India.
(Adroit Device for Handicapped and Rehabilitation)

An Innovative Idea Of A Robotic Wheelchair

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Introduction:
Movement is a very indispensable feature for any living being on this earth. Anyone denied of this feature is a half dead being. Human body is a very optimal intelligent Machine with Limbs used for movement. Some beings loose this because of many reasons. Some by birth and many by accidents, and fighting a war for their motherland, by disease like leprosy etc.

This should not hamper their lives fully in this modern and highly advanced technology ages.

Traditional Support:
A Simple wheelchair has been the tradition for the disabled and traditionally, the person sitting on the chair has to take the wheelchair by himself, pushing the wheels by hands or by some caretaker. Such type of wheelchair gives the person more burden of pushing the wheelchair and as well controlling it. So this can support him till he has the capacity to drive and apart he is very strained. In view of this one needs to give him more flexibility and comfort.

However people have improved the hand pushed wheelchair into a motorized wheelchair. Here the wheels are driven by the motor drive, and mechanical lever control for the directions. Though they claim to ease the disabled by providing motor to the wheels, there are a lot of aspects, which make it inefficient and non-supportive.

1) Control of directions mechanically.
2) The synchronization of speed and direction control is not attained.
3) Losing the control of the wheelchair can be very dangerous.
4) The person has to really work hard to improve his skills of driving this wheelchair.
5) It is very difficult for the aged people to steer this wheelchair.
6) The sick people under rest find it difficult to use.
Considering all these factors, we still haven’t given a kind of faithful and easier support to the disabled ones.

My Innovation:
As a budding engineer I’d like to present an innovation to this motorized wheelchair and name it as ADHAR – the Adroit Device for Handicapped and Rehabilitation.

1. ADHAR is an automated intelligent wheelchair.
2. The control and driving of this wheelchair is designed and configured in such a way that the user need not use his hands, need not worry about the control, just give the voice commands to the system. The system recognizes the commands and acts accordingly, controlling directions and speed.
3. Since the wheel is an intelligent wheelchair, any obstacles in the path are intelligently avoided by the in-built system; thus relieving the user from controlling the wheelchair manually.
4. The technologies of robotics, pattern analysis and machine intelligence (PAMI) and signal processing are integrated in this system.
5. ADHAR is provided with basic emergency facilities.
6. Various add-on modules can enhance the system.

So ADHAR is just like a taxi with the disabled person as the passenger. This innovation will provide an intelligent and careful driver to this taxi.

General Configuration of ADHAR:

1) For better control high torque DC servomotors actuate the wheels. Chain drives are avoided for efficiency and improvement in miniaturization, time responses and reduce wear and tear. The mechanical geared 360 grudgers rotational movement wheel with servomotor-controlled movement will give a lot of benefits.

2) ADHAR has an on-board low cost dedicated computer with very good processing capabilities and centralized computing system. A single Pentium computer with Linux OS will provide better multi-tasking operations and processing. The different sensors and the actuators are interfaced with to computer. The usage of new generation control devices like micro-controller systems on a chip can reduce the costs and improve the capabilities.

3) ADHAR has different sensors in its control loops:
   a) Vision sensors – the 360º wide field of view is sensed around the wheelchair. High performance stereovision system with monochrome or colour CCD camera is employed for analyzing 3-D images. Various image-processing algorithms are developed for edge-detection, pattern analysis and calculation of motion parameters like distance and velocity. Speech sensors – the microphones are used here to take the inputs of the voice commands of the user. The computer with speech synthesis will convert the speech in to control commands.
   c) Low cost Tachometers – these sensors are used to take the inputs of the speed of the wheels and the readings are given to the speed control module.
   d) Position sensors – these sensors are used in controlling the directional movement of the wheels. The position sensors that can be used here are simple potentiometer sensor, which is of low cost.
The Intelligent Control for ADHAR:
With the sensors, actuators, and the computer provided we can move on to build A.I. based control algorithms for ADHAR. The machine commanded control has priority over the human commanded control.

1) Direction Control:

Human Commanded Direction Control:
When there is interaction of human inputs with machine, there comes the need for better control logic. The fuzzy based control logic can solve this problem. The machine cannot interpret an
imprecise linguistic data input. Fuzzy logic converts this imprecise or uncertain data into precise or well-defined data, so that the machine can accept it for processing.

Firstly all the voice commands are pre-defined in the required language, for different operations of control of the wheelchair, like start, stop, directions control, and speed control. The microphone accepts the voice input from the user. These voice signals are transmitted to the computer for speech synthesis. The synthesized speech data is compared with the pre-defined commands and the control signal is generated and given to the direction control servo actuators.

**Computer Commanded Direction Control:**
There are many obstacles the moving wheelchair can face. If the user is to be relieved of steering the wheelchair, the obstacles should be intelligently avoided. These obstacles can be some solid objects, or potholes or anything that might cause collisions and imbalance. The input from vision sensors is taken to the image processing blocks. The algorithms of pattern recognition and image processing formulate the data pertaining to the distances of the obstacle from wheelchair, surface parameters of the obstacle like edges, and the regions around the obstacle. This data is fed to the A.I. based path-deciding algorithm. The path-deciding algorithm calculates the distance from the obstacle at which the deviation has to take place. After the decision on the deviation is made, the control signals are given to the actuators of the wheels and accordingly the wheelchair moves avoiding the obstacle. Since the decision of movement cannot be taken at once, a continuous feedback is needed.

2) **Speed Control:**
The next aspect is the speed control. The maximum speed is about 4kmph. The speed control block gets commands from both the speech synthesizer and the obstacle-avoiding block.

**Human Commanded Speed Control:**
The user will have override for speed control but the planned control is the exact fuzzy logic based automatic speed determination. The command given by the user will be something like “slow down” and comparatively the speed has to be reduced. Here step reduction in speed can be implemented.

**Computer Commanded Speed Control:**
The speed has to be as well slowed down during obstacle avoiding operation. Along with the direction control a simultaneous signal is sent to the speed control block. A constant lower speed of about 20-25% of maximum speed can be permissible during obstacle avoiding. When the obstacle-avoiding block shows the safe zone without any obstacle, the speed has to again increase to maximum.
We observe that there are many variations in speed that take place; it is necessary to avoid jerks due to these variations. The solution to this is adequate damping factor to be provided to the servos and a suitable control algorithm to be implemented.

**Safety and Emergency:**
The next important factor is the emergency and the safety system.

a) The electrical failure causes a trigger. This trigger is given to a mechanical actuator and the mechanical brakes are activated thus halting the wheelchair.

b) A fire extinguisher is facilitated.

c) Wireless telephony system is attached for emergency communications.

d) Low battery alarming is added.

**Important Considerations:**

a) The capacity of the servomotors has to be pre-determined judiciously. However servomotors can be replaced by DC motors.

b) The technique of regenerative braking i.e. application of reverse torque is employed for avoiding the effects of gravity over the motor control; especially during slopes.

c) The most important consideration is power supply. The weight should be less and the capacity is to be adequate for efficient usage. Rechargeable Ni-Cd or lead acid batteries can be one of the choices.
**Enhancing ADHAR:**
Various add-on modules can enhance the ADHAR system.

a) Speech controlled lighting system for night usage.
b) If the user has health problems, a medical monitoring system can be added. Parameters like blood pressure, heart rate, glucose levels, etc., are readout by different biomedical equipments and the data of the patient is transmitted wirelessly to the doctor-in-charge.

**Advantages of ADHAR:**

a) Versatile usage – people without limbs, who are physically weak, mentally retarded, and aged can use ADHAR. The sick people who are under complete rest can use this without much trouble and mental exhaustion.
b) Intelligent control – the user need not take care of the motion and path, he has to just give commands, which are very flexible.
c) User friendly – on the whole the system is very user friendly.
d) Reduction of vigilance – there is not much need of a human caretaker in presence of ADHAR.
e) A person without hands also need not worry about using the wheelchair.

**Discussions:**
ADHAR will face many challenges in India, like:

a) Safety
b) Infrastructure and technology to carry out the R&D on the project.
c) Cost
d) Utility

The on-board emergency and safety facilities are adequate for tackling the dangers.

As India produces a number of genius engineers the development of the technology for the different components and the system, indigenously is not very difficult. The control engineering companies have to concentrate on R&D on A.I. and signal processing. The R&D organizations can take up the project. The project is not a very big burden on the Indian government.

As the technology and the components are going to be indigenous, the cost is sure to be lower than those that would be built in foreign countries. If the cost is nominal, various rehabilitation centers and individuals can afford the device and this cause can be supported by government and social institutions by providing good subsidy.

We can help our soldiers who fight for us in the wars, many with genetic disordered and also who are victims of accidents and diseases.

**References:**
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