DESIGN AND FABRICATION OF A VEHICLE FOR HANDICAPPED PERSON.

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Abstract:
At present, handicapped people are finding difficulty in having a job or to find their earning. The objectives of this study are to find out a new way of making money for the handicapped people by considering all the safety parameters. The main tool used here is a vehicle which should be modified, the other tool used is a wheelchair which is also been modified for the ease of the handicapped person into the cabin. The assessment consists of two phases, first phase deals with the fabrication and modification in auto rickshaw and wheelchair for comfort and convenience to the handicapped person while entering or leaving the vehicle. The second phase is the design of motor and flap in order to help the handicapped person to enter the cabin using a DC motor. This study will reveal that it will be optimal way for the handicapped people to find their own earnings.

Keywords: paraplegic person, auto rickshaw, wheelchair.

Background
Today we know that handicapped people find out their earnings through lottery business or other small scale jobs. Some of the people are also struggling to find a job or to find a earning for their daily needs. Only less than 2% of handicapped people uses vehicle for their earnings this is because the difficulty faced by them while entering and driving the vehicle. This difficulty can be overcome by
doing some innovations in the vehicle design. In this work we cannot employ hydraulics in our proposed work because it is very expensive, complicated and its maintenance cost is also high. Therefore hydraulics is present in the existing technologies which is very expensive and founded that it will be not a suitable solution for the handicapped people because the best solution will be always simpler and also cheap.

The idea is to create a new design for the existing design of the vehicle so that the handicapped one can easily enter and exit from the vehicle. Our innovative modifications consists of a flap through which the wheelchair can enter into the vehicle. The flap consist of a guide way through which the wheelchair wheel moves into the cabin. The wheelchair moved through the flap is done with the help of a motor which is connected to a torque increasing system which reduces the speed and increases the torque. Metallic wire rope is wounded over the shaft which can be can be attached to the wheelchair and the motor pulls the wheelchair into the cabin. There is no seat inside the cabin the wheelchair itself enters the cabin and get locked inside the cabin. Similarly the person can use the same procedure for moving out of the cabin. The other problem is that the braking system we are combining the brake into a single pedal so that only one hand is used for braking which is just same as that of a car but the brakes are applied by using a hand pedal. From this the handicapped person can easily control the gear system as well as the brake with his two hands. The next modification is providing push start stop button so that the person can easily start and stop the vehicle. It consist of a flap through which the wheelchair is been advance to the cabin with the help of a DC motor.

The gear system is same as that of a normal vehicle which can be controlled by his hands and the brakes in legs is been changed to hands by using a mechanical connector so that the handicapped person can easily apply brakes to his other hand. The principle of brake is same that of the old vehicle. This changes can help the disabled person to drive the vehicle easily. As the cabin height increases it’s better to increase the height of the roof so that we can avoid collision of head of the disabled person on the roof. This changes can make the vehicle easy and safer to drive for a handicapped person.

Engineers sometimes prefer to use pneumatics because they are quieter, cleaner and cheap than the hydraulics [1&2]. When it comes to the case of hydraulics its properties decide high efficiency, security as well as stability under different working conditions [7].

Methods

This idea can be established by providing a flap which is in contact with the ground therefore the wheelchair enters into the cabin using DC motor through the flap. DC motor is preferred because it is ideal for carrying load in vehicle applications [3&4]. For better comfort and convenience of the handicapped person the interior design of the vehicle has been changed such that driver cabin space is been increased and cargo space has been reduced.

The work can be implemented very easily. First the chassis of the vehicle should be made strong because the driver cabin may have more load than the normal condition and also some parts of the chassis should be fragmented. As the height of the cabin should be increased to make the surface flat. The material used for flat surface is japan steel of 16 gauge. After the fabrication of the sheet a small space should be provided in order to attach the lever in the brake pedal so that brake can be operated by using hands. The position of brake lever is an important factor and it is kept just below the accelerator pedal because the lever should be in a place where handicapped person can easily apply.

The flap is made of plywood so that it can support large load as well as less weight compared to other materials. The flap is divided into two halves so that when the door is closed it will be comparatively small and also it adds the entire aesthetics of the vehicle. One end of the flap is hinged in the vehicle cabin and the other end is with the other end of the second flap. The second flap has a contact with ground and the total flap has a slope of 30 degrees. The wheelchair advances through the flap which has a contact in the ground with the help of a DC motor of 12V with a gear so that we can easily pull the wheelchair. The flap consist of grooves so that the wheelchair wheel will move through the groove and will not have a chance to slip on the flap. When the person enters the cabin by using a rotating roller he can easily turn inside the cabin and face in the driving direction. Using the start/stop push button he can start the vehicle and can drive the vehicle like a normal one. There is a lock system inside the cabin which locks the wheelchair inside the cabin so chance of moving of wheelchair inside the cabin while travelling is avoided.
The DC motor alone itself cannot pull the wheelchair inside the cabin for the task we have to increase the torque for this we have made a new system which consist of a pulley and a gearbox [5]. The motor pulley is directly connected to the larger one side pulley which reduces the speed of the motor and then it is connected with the gearbox. The gearbox consist of two gears which the one gear has 24 teeth and the other has 29 teeth. This transmission increases torque and the output of the gearbox is connected with the shaft in which the metallic wire rope is wounded and these wire rope is used to pull the wheelchair inside the cabin by clipping the hook present in the rope to the wheelchair.

Then the DC motor is connected to the battery when the handicapped person reaches close to the vehicle he can easily open the flap and start the motor with the help of a remote. At the mean time the motor is connected with the belt which can be clipped into the wheelchair. This belt should have tension strength to avoid ripping of the belt. The belt connected to the motor is moving through the winch system. After connect the belt the motor pulls in the wheelchair inside the cabin as there is grooves provided in the flap the chances of slip is reduced. There is a mechanical lock given inside the cabin to lock the wheelchair in order to cease the movement of wheelchair. Similarly while the person want to move out he should start the motor and attach the belt and he can simply and safely move out of the cabin through the flap. At last close the flap manually and the handicapped person can move anywhere.

The surface of the cabin should be made flat we should redesign the wheelchair and decrease the height of the wheelchair for more comfort to the paraplegic person [6&10]. The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design and the factors required to make this type of wheelchair is the seven principles which include equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and appropriate size and space. Implementing start/stop push button makes more convenient to the paraplegic person by starting the vehicle in one push. Push switch allows electricity to flow between its two contacts when held in. When the button is released, the circuit is broken. This type of switch is also known as a Normally Open (NO) Switch [9].

**Design Details**

Plywood is used as the flap material because it has good stability, impact resistance, good strength and also light weight compared to other metals or other materials. The plywood used in this work having thickness of 12mm can carry a load of 50kg at a time. Therefore the studies are done with considering the maximum load that the flap can hold.

Flap size is measured by identifying the slope from the cabin to the ground. By trigonometric relations we get the dimensions of the flap as 810mm×920mm and the slope will be

\[
\sin \theta = \frac{\text{Opposite side}}{\text{Hypotenuse}} = \frac{47}{92} = 0.510
\]

Therefore \( \theta = 30.663^\circ \)

Motor Specifications (used in this study):

- 50W, 8500rpm, HP-1/12.
- Required Power: 42.62W

**Calculation:**

- Mass of the object to be pulled: 50kg
- Acceleration in wheelchair in slope from [8], $1\text{lb} \rightarrow 0.0595\text{m/s}^2$
- Therefore $50\text{kg} = 6.558\text{m/s}^2$
- Force, \( F = ma = 50 \times 6.558 = 328\text{N} \)
- Work done, \( W_d = F\times\text{Distance} = 328\times91\text{m} = 298.39\text{m} \)
- Required Power, \( P = \frac{W}{\text{Time}} = 298.39/7 = 42.62\text{W} \)

As power transmission takes place from motor to a pulley then to the gear box which is connected to the shaft

**Specifications:**

- Size of pulley: 8inch (20.32cm)
- Gear ratio = \( \frac{\text{Teeth of 1st gear}}{\text{Teeth of 2nd gear}} = \frac{24}{29} = 0.827 \)
- Max Speed of motor: 8500rpm
- Average speed of pulley: 2150rpm

Motor is attached to a gear in order to convert speed into torque, which is required in this study.

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Torque of motor

\[ T_{motor} = \frac{P \times 60}{2\pi N} = \frac{50 \times 60}{2\pi \times 8500} = 0.152 \text{Nm} \]

Torque obtained in shaft

\[ T_{shaft} = \frac{50 \times 60}{2\pi \times 300} = 1.6 \text{Nm} \]

Therefore the torque is increased by using our new transmission system.

Design of gear:

Power, \( P = 0.05 \), No of teeth in first gear, \( Z_1 = 29 \), No of teeth in second gear, \( Z_2 = 29 \), Speed of second gear, \( N_2 = 300 \text{rpm} \)

Gear ratio = \( \frac{Z_2}{Z_1} = 0.8275 \)

Assume both be the same material

Assume to be full depth

Design stress of Cast steel = 193.2N/mm²

\[ y_1 = (0.154 - 0.912/2) \]
\[ y_2 = (0.154 - 0.912/24) = 0.116 \]
\[ y_1 = (0.15 - 0.912/29) = 0.122 \]

Therefore gear is weaker member.

Calculation is done based on gear

Tangential tooth load, \( F = (P \frac{C_v \times 1000}{C} \frac{1.5}{v}) = \frac{1000 \times 0.05 \times 1.5}{\pi \times 24 \times 300} \frac{m}{6000} \)

\[ F = 198.084 \frac{m}{m} \]

Speed of Gear 1, \( N_1 = 0.827 \times 300 = 248.1 \text{rpm} \)

By Lewis equation tangential tooth load equals

\[ F_1 = \pi \sigma_v \times C_v \times b \times y \times m = \pi \times 22.412 \times C_v \times 10 \times m^2 \]
\[ F_1 = 704.068 \ C_v \times m^2 \]
\[ 0.2827 = C_v \times m^3 \]
\[ C_v = 0.5 \text{ m}^3 = 0.565 \]

Select module, \( m = 1 \)

Mean velocity, \( v = \frac{\pi \times 1\times 29 \times 300}{6000} \)

\[ v = 0.455 \text{ m/s} \]
\[ C_v = \frac{3.05}{3.505} = 0.87 \]

\[ 0.87 \times 1 > 0.282 \times 1 \]

Wheelchair Dimensions:

Back tyre radius: 400mm

Front tyre radius: 50mm

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Description</th>
<th>Dimensions in cm</th>
</tr>
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<tbody>
<tr>
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<tr>
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<td>Seat width</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>5</td>
<td>Footrest width</td>
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</table>

Results

In order to make the cabin flat the cabin height of the vehicle should be increased so for better convenience and comfort the height of the roof of vehicle is been increased and this modification will not change in any gyroscopic effect of the automobile. DC motor with gear systems are suitable to carry heavy load than the AC motor as it is complicated circuits and may have a chance of system failure. This changes can help to develop vehicle which can be easily used by the handicapped people.

The above work can be easily developed in an ideal way and can help the handicapped people a new way of earning money. As the height of the cabin is been increased the height of the roof of the vehicle should be increased in order to have a better comfort and convenience of the handicapped person. The brake lever should be kept in a position that the handicapped person can easily and instantly apply the brake in case of an emergency situation. DC motors are more preferable than AC because for AC motors separate converters are required in order to connect with the vehicle source (battery). The DC motor connected to the vehicle should be connected


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to gear system to increase the torque which is required to pull in the wheelchair inside the cabin.

Fig 1. It shows the different work in the proposed study.

The above figure shows the different implementations made in this work the first figure shows the locking system made to resist the motion of the wheelchair while driving. The second fig shows the newly designed wheelchair and the other figure shows the flap through which the wheelchair moves inside the cabin. Next figure shows the fabricated pipe which can be used by the paraplegic person to apply brake with his hands. The other figures shows a hook and a wire rope by which the wheelchair is pulled in to the cabin with the help of a motor. The last figure shows start push button which is implemented in this project for providing more reliability and convenient to the paraplegic person.

Conclusion

The work can be easily developed in an ideal way and it is also the technique with less expensive compared to other techniques. The work consist of modifications of the vehicle design and all the modifications are necessary for providing better comfort and convenience to the handicapped people. Other techniques like hydraulics can be done for the same work but it is very expensive and more complicated system than the proposed work. The work doesn’t require any external power source and also the studies proved that the proposed work doesn’t affect the efficiency of the vehicle too.

From the results, this work can be easily implemented and developed in an optimal way so that a handicapped person can easily drive the rickshaw and also considering all the safety factors. This studies had proved that all this modification can be done to help the handicapped person. In future some modifications like automatic transmission, using of electric engines can be done in order to increase the specifications of the idea and also to increase its benefits in the society.

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