Design and Development of Light Weight Multi-Utility Electric Scooter using Hub Motor Transmission

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Abstract: This project is aimed at designing and developing of a light weight multi-utility electric scooter using hub motor transmission. The proposed vehicle is capable of doing versatile operations in various fields such as material handling in small scale industries, for carrying agricultural products and also can be used for short distance transportation purpose with much ease. Keywords: hub motor power transmission, regenerative system, transportation, material handling and goods carrier.

I. INTRODUCTION
The proposed project of designing and developing of light weight multi-utility electric scooters using hub motor transmission is aimed at developing an electric scooter which is reliable for the customer to use it in multi-purpose operations such as carrying goods and also for short distance transportation. The proposed scooter is light in weight which makes the customer feel much easy while running it and the project is also economical which makes it more affordable.

Since the scooter runs on the battery it is environment friendly and the inclusion of regenerative system will increase the efficiency of the scooter.

RELATED WORK
A. Purpose of the document
This paper is reference to the further development of light weight multi-utility electric scooters using hub motor transmission. The purpose of this paper is to describe the design, requirements and fabrication of our project.

B. Scope for development of this paper
The multi-utility electric vehicle can be used effectively in the non automated small scale industries for material transferring and also physically challenged people can use it for transportation purpose.

C. Main Modules of the system.
- Hub motor: in this project we are using a brush-less DC hub or in-wheel motor for the transmission of power form battery instead of using conventional chains or shafts for power transmission.
- Battery pack: we are using 4 sealed lead-acid batteries connected in series which supplies the power to the hub motor.
- Regenerative setup: the inclusion of regenerative setup has made the vehicle more efficient since some of the power can be recaptured while the vehicle is running.
- Mild steel chassis: use of seamed mild steel tubes for chassis has made the vehicle weigh much lighter.
- Controller setup: a suitable controller system is installed to compensate the excess voltage problems. It consists of an MCB.

D. Existing vehicles:
Now we have the electric scooters which are used for the transportation purpose and also we have industrial towing trucks for material transfer in industries.

Drawbacks of these are:
- Electric scooters can be used only for transportation, they cannot carry more load.
- The towing trucks or tuggers used in industries are costlier and they are not affordable for the non-automated small scale industries.

E. Proposed model:
The proposed system is nothing but the integration of the electric scooters with the industrial load carriers into a single vehicle. so that the customer using it can get the privilege of using it for both the transportation purpose and also for load carrying. and the proposed model is lighter in weight, requires less maintenance and economical so that the can afford it easily.

II. METHODOLOGY
- Our primary concern was the non-automated small scale industries to know the problems faced by them in material handling within the plant.
- Then the next priority was the agricultural farms in which there needs to be transferring of crops sacks and milk containers etc.
- We met people both from the industries and the agro-farms and came to know the problems faced by them.
- Based on the data collected by them we started designing our project.
• First we have chosen mild-steel for making chassis, in order to reduce the weight of vehicle and make it economical.
• Then we designed few different chassis designs and then based upon our loading requirement we finalised the chassis design. Then we carried on the analysis of chassis by using NX-NASTRAN version 7.5 software under static loading conditions.
• Further we have planned to make the analysis for the dynamic loading conditions.
• After the analysis of chassis, we carried on the welding of chassis by arc welding as per our required dimensions using the seamed mild steel tube, because seamed mild-steel tubes are light in weight and cheaper than the seamless tubes.

III. DESIGN PROCEDURE
First we drawn some rough sketches of the chassis with different dimensions and then based upon our loading requirements we finalized the chassis model. Then we created the sketch in camd software then we carried on the static analysis by using the NX-NASTRAN software by assigning point loads at different points on the chassis.

IV. FABRICATION
After the static analysis using NX-NASTRAN is done, then we fabricated the chassis by using the seamed mild steel chassis, and the welding is done by MIG welding and powdering.

V. FINAL ASSEMBLING OF ALL COMPONENTS
Now the vehicle chassis is done as per the required dimensions. The final assembling is done by assembling the in-wheel or hub motor in the rear wheel and the battery setup is also tested properly for easy usage. the controller setup consisting of regenerative system is connected to the motor properly and then the vehicle is tested.
VI. COMPONENTS USED AND SPECIFICATIONS

- Material used: mild steel tubes of 2 mm thickness.
- Size of vehicle: -180*75*50 inches.
- Hub motor: 12 inch, 600w, 48v.
- Controller: 500w, 48v.
- Dry weight: 80 kg.
- Weight of vehicle with batteries: 102 kg
- Maximum load carrying capacity: 350kgs.
- Maximum speed: 35-40km/hr.
- Battery capacity: 12v, 35Ah (4 batteries in series)
- Torque output: 4.2N-m

VII. POWER TRANSMISSION AND WORKING OF REGENERATIVE SYSTEM.

The transmission is done by using the sealed lead acid batteries connected in series of 48 volts and 35 Ah capacity (4 in number) which can be rechargeable, for this a suitable plug system is provided in the vehicle. The power from the battery is then fed to the hub motor which is placed in the rear wheel. By this the vehicle starts running.

The regenerative system can be employed in the hub motor itself and it does not have any separate components.

The stator and rotor is composed of coils. While we throttle the vehicle, battery supplies electricity to the coils, so the coils will behave as magnets which make the coil rotate inside the magnets. When we release the throttle, then the rotor will be rotating inside the magnetic field. So when the coils rotate in the magnetic field there will be generation of electricity which is used to recharge the battery as per the calculations practically we achieved 30% of the used energy during testing.

VIII. TESTING AND EFFICIENCY

- Battery specification: 12v, 35Ah (4 batteries in series-48v)
- Maximum charging capacity for one battery: 13.5Ah (for 4 battery 4*13.5=54v)
- Total discharging time for 4 batteries in series: 1 hour (with load), 1 hour 15 min (without load)
- Regenerative power restored for series connection : 30% of battery discharged.

ADVANTAGES

- Lighter weight, almost 40-45 kg of weight is reduced as compared to the existing electric scooters.
- Economical, the cost our project ranges from 25-30k which is much cheaper as compared to the existing electric scooters.
- No regular maintenance is required, since no chain or shafts are used for the power transmission.
- No need of frequent charging of battery is required because of the inclusion of the regenerative system, which recharges the battery while the vehicle is running.
- The vehicle is more reliable for usage.

IX. LIMITATIONS

- Load carrying capacity depends upon type of battery used, i.e., higher the Ah higher the load carrying capacity.
- Not suitable for long distance transportation.
- Hub motor placed in the wheel sometimes may cause the improper turning of the vehicle.

X. APPLICATIONS

- Can be used for the material transfer and handling in small scale industries.
- Can be used for carrying the agricultural products such as crop sacks and milk containers.
- Suitable for the short distance transportation.
- Vendors can easily use it to sell products because of inclusion of carriage.
- Physically challenged people can also use it with much ease because of its light weight.

XI. FUTURE SCOPE

Electric vehicles are considered as the future of next generation. Since it uses the electric power as the source of energy, since the non-renewable resources such as petrol, diesel etc are depleting, there is a need to find an alternate source of energy.

Hence these electric vehicles are much suitable in such scenario, though these electric vehicles have most of the advantages it also has many disadvantages such as the battery requires frequent recharging and the disposal of these battery is also a problem.

To overcome these charging problems we in this project have included the suitable regenerative system through which we are able to get back the utilized energy up to some extent but the limitation of this system is that we can’t get all the utilized energy back.

Hence another better alternative has to be found out to overcome these limitations.

The solar energy for charging the battery is one of the best alternatives, and this can be implemented by changing the design of the vehicle, by using the suitable solar panels the energy requirements can be easily fulfilled. Making the vehicle more efficient for the usage and making no environment pollution.

XII. CONCLUSION

In our project we have achieved all the objectives which we were planned. As it is difficult to transfer the goods from one place to another in small scale industries our vehicle is useful in those scenarios as it is capable of carrying 300kg load and it is also economical when compared to other electric vehicles available in market.

As the fossil fuels are nearer to extinction we should make use of alternative energy sources and also using it efficiently. So we not only considered for providing a vehicle for transportation apart from it we tried to make it efficient by inclusion of regenerative system.
The vehicles carrying capacity can be increased by using the motor of higher watts and using of battery of higher Ah.

XIII. REFERENCES

[1] Abdul hafiz bin raml; ‘design and development of single seater electric scooter for short distance application’.


