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# Design and Development of Detachable driving/propulsion device for low weight carrying capacity of carrier or trolley.

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**Abstract—*This work/project is about to provide solution for manual pushing of carrier/trolley. Pushing and directing loaded or unloaded carrier/trolley includes applications in material handling for food industries, packaging and logistic industries, airports, shopping malls and supermarkets. This activity consumes lot of energy and effort for propelling and walking. This project aims to give conceptual and partial design for a kind of attachment, which can power cart/trolley in propulsion. In the design of this attachment, shopping cart is used for demonstration purpose. The attachment is detachable so attachment can be detached whenever needed. Purpose of this project is to open new area of study in the field of optimisation and ergonomics to make manual cart to electrically power.***

***Keyword:-Detachable Device, Electric Vehicle (EV), Rechargeable battery, Power rating, Propelling attachment, Battery powered vehicle, motorised Shopping trolley***

## I. INTRODUCTION

In some applications, carrier/trolley propelled by human is used, like handling light weight goods or materials in various industries, handling luggage at airports. Also, this same carrier/trolley can be used in packaging and logistic hubs for low weight applications. Other applications are at food industries, super-markets etc. One of those applications, most widely used cart/trolley is “Shopping Cart”.

Since, all above applications involve human as a propellant (i.e. any object/substance/device that propels or cause to move forward with force.). It consumes considerable human effort for walking on the floor, propelling and directing of carrier/trolley. Generally these applications like food industries, pharmaceutical industries, super markets, shopping malls, airports etc. has greater floor area to be cover by walking only.

Material Handling Equipment has very wide scope in industries. A brief classification of Material-Handling Equipment is as follows:

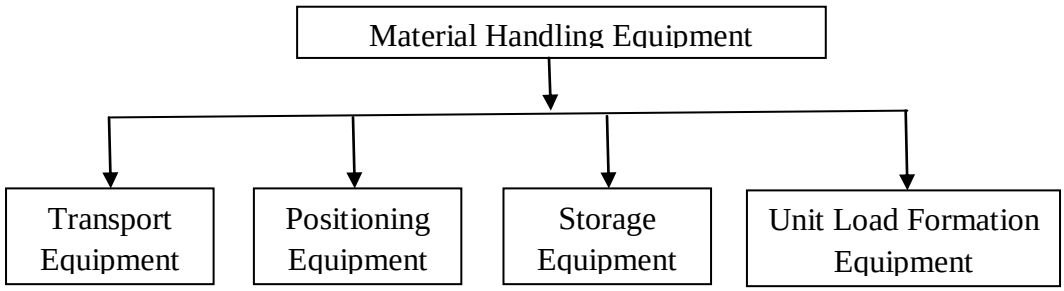


**Fig. 01. Basic Classification of MHE**

This classification is to show the category of carrier/trolley, which falls under the category of transport equipments.

## II. LITERATURE REVIEW

Meilan Zhou et al. (2015) [1] worked on Pure Electric Vehicle Power-train Parameters Matching based on Vehicle Performance. In that they studied on electric vehicle's dynamic performance and economic performance as well as to drive motor with help of battery in software CRUISE and help to understand the development of automobile power system.

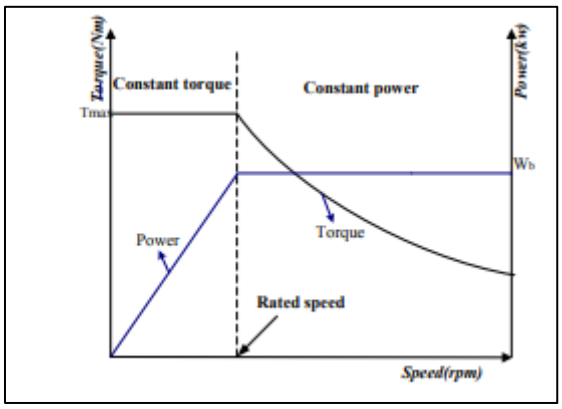


**Fig. 2. Drive Motor Torque Characteristics**

SwarajRavindra Jape et al. (2017) [2] worked on Comparison of Electric Motors For Electric Vehicle Application. In that they studied on different types of motor according to weight, torque, speed, efficiency and cost of motors.

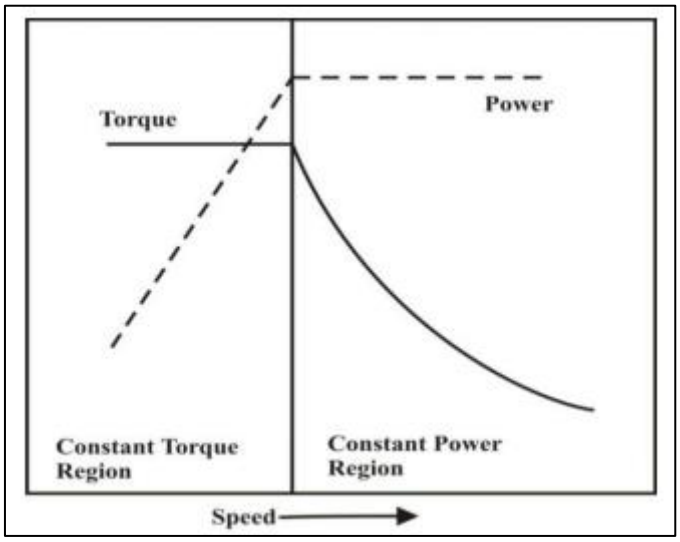


**Fig. 3. Ideal mechanical characteristics of electric motor in EV**

Mr. MadhukaraNayak et al. (2015) [3] worked on Fabrication of Automated Electronic Trolley.In that they studied on problem faced by users in supermarket while purchasing and to overcome this problem they construct automated trolley which work by RFID (Radio Frequency Identification) to move trolley by help of android system.

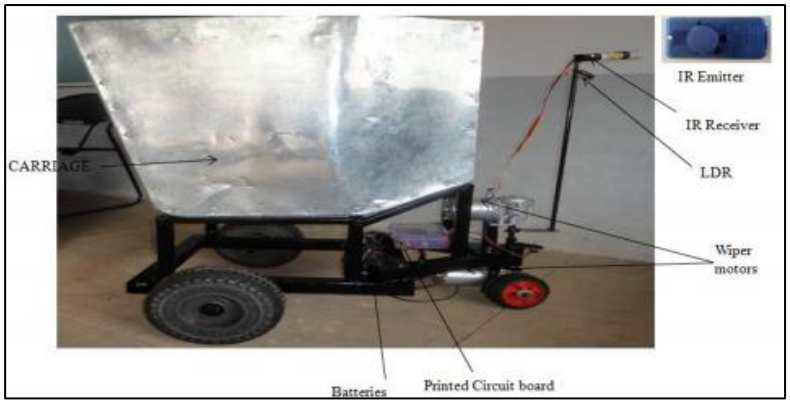


**Fig. 4. Electronic components of trolley**

Ms.VaishaliBakshi et al. (2014) [4] worked on Drive Selection and Performance Evaluation of Electric and Hybrid Electric Vehicles. In that they studied on performance of EV and HEV by Permanent magnet Synchronous Motor (PMSM) and Induction Motor (IM) drive train.

T.Porselvi et al. (2017) [5] worked on Selection of Power Rating of an Electric Motor for Electric Vehicles. In that they studied on BLDC motor based on speed and torque according to weight along with calculation procedure.

Saurabh Chauhan (2015) [6] worked on Motor Torque calculations for Electric vehicle. In that we got idea about design methodology to begin with load calculation first. Also idea about factors affecting the required torque is extracted from this literature. In fact, starting base for design calculation like maximum torque, rolling resistance, grade resistance and acceleration force.

Virag A. Timbadia et al. (2017) [7] worked on Design and Development of a Multi-Purpose Trolley. In that they fabricated an automated trolley which can be easily handle for different purposes to carry heavy load easily and reduce human effort.

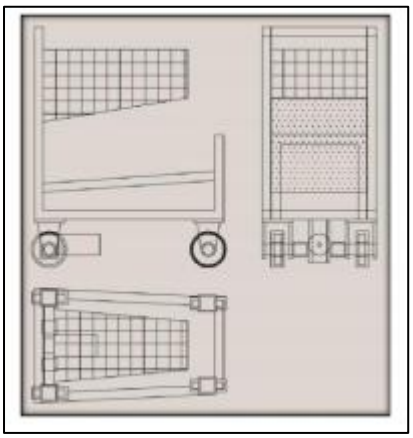

**Fig. 5. Line diagram of multi-purpose trolley**

Asst. Prof. V.B. Vaidya et al. (2017) [8] worked on Design and Implementation of Automated Trolley by Using Mobile Frequency. In that they studied to move heavy trolley by help of a cellular cell by GSM network of any network.

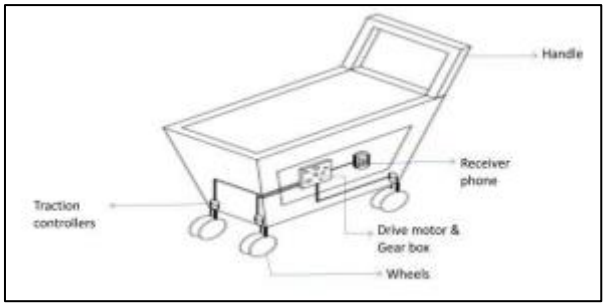


**Fig. 6. Four wheels driven automatic trolley operated by mobile frequency**

## III. OBJECTIVES

- To develop detachable propulsion device.
- To reduce walking and propulsion effort of human.
- To reduce material or goods handling time.
- To provide attraction to users of manual handling trolley.

## IV. DESIGN CONCEPT/IDEA AND CALCULATIONS

Initial idea to provide solution to reduce walking effort was to design the segway PT (i.e. personal transporter) like attachment to carrier. After several modifications, final detachable device was constructed for shopping cart. It contains two gear motors, two driving wheels, two swivel wheels, a metal plate etc. These individual components are explained in subsequent section.

Following is the flow of execution path way by which design and development of Detachable device is done.

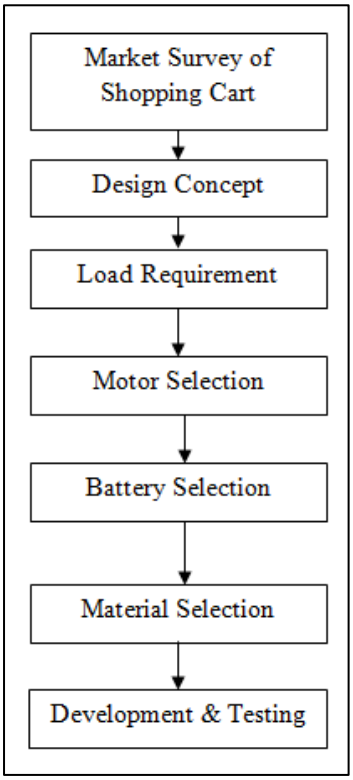


**Fig. 7. Flow path for design execution**

**Assumptions:**

1) Only one man or women can stand and operate a device.
2) Maximum human weight is limited to 80 Kg.

3) Maximum weight of grocery is limited to 35 Kg.
4) Customer is willing to travel through supermarket at single constant speed with shopping cart by standing on Detachable Device.

Initial idea to provide solution to reduce walking effort was to design the segwayPT (i.e. personal transporter) like attachment to carrier. After several modifications, final detachable device was constructed for shopping cart. It contains two gear motors, two driving wheels, two swivel wheels, a metal plate etc. These individual components are explained in subsequent sections.

## V. SELECTION OF COMPONENTS

### 1. SELECTION OF ELECTRIC MOTOR

Firstly based on condition of human and carrier load deciding the capacity of motor. This gives required torque value. This torque takes rolling resistance, grade resistance and acceleration force in account for total tractive force. By multiplying total tractive force with radius of driving wheel,that is 100mm, we get required torque at driving wheel.

- Required torque at driving wheel = 9607 N*mm
- Maximum torqe = 16,334N*mm
- Here, maximum permissible torque is greater than required torque. Hence, it shows that driving on this attachment is safe.
- Required motor power to generate required torque stated above = 192.44 watt = 200 watt which is equivalent of 0.2 kW (kilowatt).
- But we know that application here requires two electric motor, one on each driving wheel. So two electric motors of 0.1 kW capacity is used to generate required torque and power output.
- In this work, two numbers of 12 V, 9 A having 45 rpm DC gear motor is used.

### 2. SELECTION OF RECHARGEABLE BATTERY

Necessarily, in this work rechargeable battery is only an only option to use. But, still many conditions to be fulfil by that rechargeable battery. Like,

1) It should take less charging time.
2) It should have long discharging time.
3) It should be safe to use in human vehicle.
4) Easily available in markets.
5) High weight to power ration.

- Considering, all above factors and power requirement of DC electric motor of 12 V and 18 Ah (Ampere*Hour) battery should be kept for minimum one hour of continuousoperation.
- With the help of using 9 A output current charger, the stated battery can be charged in 2 hours of charging.
- It means that 2 hour of full charging can travel the user for 1696 meters (1.696 kilometres).
- From literature review it is known that dry-cell Li-ion battery is suitable for application. Li-ion battery having Lithium Iron Phosphate ($LiFePO_4$) chemistry can give the best result.

### 3. SELECTION OF MATERIAL

Material to be select should have following characteristics fron design point of view:

1) It should have good machinability.
2) It should have high strength to weight ratio.
3) It should be easily available and economical.
4) It should have long life and less corrosive.

Considering all above and other parameters like human ergonomics and cost of project etc. high strength, low carbon, hot rolled steel plate of grade ASTM A36 is used as Material of Construction (MOC).

## 4. SELECTION OF CONTROL SWITCHES

Here, application demand to run the motor in both directions i.e. forward and backward. To make it happen DPDT (Double-Pole, Double-Throw) is used in-between battery output and motor input.

## 5. RESULTS

**Fig. 8. Model of Detachable Driving Device in attached condition**

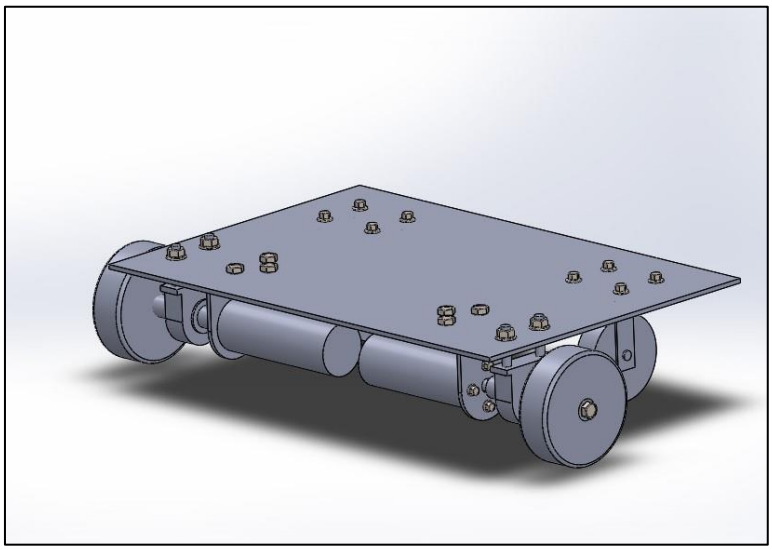

**Fig. 9. Model of Detachable Driving Device alone**

## VI. CONCLUSION

- It is clear from above discussion and literatures that carrier/trolley, which has wide application in material handling could be partially automated.
- Detachable device with rechargeable battery and DC electric motor can be controlled with DPDT switches as a controller.
- User of manual pushing type carrier/trolley would enjoy detachable driving device by attaching trolley to this driving device.

## VII. FUTURE SCOPE

1) The variable speed drive can be designed.
2) Customized manufacturing of battery can be done to optimized battery performance with particular motor used.
3) It Can be provided with Up down lifting mechanism for users.
4) Robotic Arm mechanism can be added according to requirement.

## ACKNOWLEDGEMENTS

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