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Generalised EV Conversion Kit

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Abstract: *The world is looking for alternate sources of energy to fuel the vehicles, electricity is one of the best alternatives available. But while we buy new vehicles from the market there is still a problem that arises where there are already existing vehicles in the market, where we can just make changes to the already existing models by replacing them with all the necessary components and systems. As also the problem in this space is that there are different types of models available in the market from different manufacturing companies. Hence instead if we need to retrofit a vehicle we need to design a kit for each of these models. Though this process is relevant it is a time-consuming process. In order to solve this problem we are classifying the vehicles into two categories specifically Motor Cycle Without Gear [MCWOG] and Motor Cycle With Gear [MCWG] and then design a retrofitting kit for these categories instead of the vehicles. This project focuses on MCWOG category of vehicles where an expected model is designed using the SOLIDWORKS and the drive cycle analysis of the kit was studied in the MATLAB/SIMULINK model and is presented in the paper. The following project shows adaptation of new technology, its feasibility and reuse of the old vehicles.*

Keywords: EV

I. INTRODUCTION

An electric vehicle uses one or more electric motors or traction motors to provide momentum in a vehicle. EV's can be powered by a battery pack which is onboard. However, in hybrid electric vehicles (HEV) it is powered by converting fuel energy to electric energy which powers the motor. Transportation should provide users freedom of mobility, sustainable mobility, economic growth of a country and prosperity for society. In order to achieve these objectives, vehicles driven by electricity from clean, secure and smart energy are essential.

In India for retrofication of EVs GoGoA1 is one of the companies which provides retrofication for the Hero Splendor model of vehicle. Hero Splendor contributes to 25% of the total vehicle market in India, which means 75% of the market is still untouched. In order to cover this huge space we propose an idea for design of an EV conversion kit which is suitable and can be easily fitted into any of the existing two wheelers. For this purpose, we categorise the vehicles as Motor Cycle With Gear [MCWG] and Motor Cycle Without Gear [MCWOG]. The current paper focuses on MCWOG category of vehicles.

The Government of India has set an ambitious target for electric vehicles (EV) alongside plans to reduce carbon emissions via diesel and petrol engines significantly by 2030. With this in view, the country is taking steps towards switching to EVs. However, the pace of this transition cannot be dramatic and thus, to complement the addition of new EVs, retrofitting existing ICE (Internal Combustion Engine) vehicles is a given requirement. Retrofitting increases the useful life span of existing vehicles by 5-7 years and allows them to not fall in the trap of scrappage policy

Economic benefits of retrofitting - While retrofitting an old ICE 2-wheeler may cost between INR 50,000 – 1 lakh, buying a new electric 2W with similar power may cost up to INR 1.5 lakh. Besides, retrofitting an ICE vehicle saves on fuel costs, which may be up to INR 50,000 – 60,000 per year for a petrol motor bike. When it comes to an E2W, the cost of charging the vehicle per year will not be more than INR 7,000-10,000.

Calculations:

Motor Selection:

Load Calculations -

Total load applied to motor - vehicle weight (excl. engine) = 110 kg

Rider and Accessories = 80 kg

Total Load = 110 + 80 = 190 kg

Drag Force Calculation -

Coefficient of Drag $C_d = 0.5$

Density of air $\rho_{air} = 1.293$ kg/m3

Cross Sectional Area A_c = Height x Width = 0.6 m^2

Velocity v = 8.33 m/s

Drag Force $F_d = ½ \rho_{air} A_c C_d V^2 =$ **13.45 N**

Rolling Resistance Force and Gradient Force Calculation -

Coefficient of rolling resistance $\mu_{rr} = 0.004$

Weight of Vehicle = 1862 N

Rolling Resistance Force $F_{rr} = \mu_{rr} \times$ weight = **7.448 N**

Gradient Force $F_{gr} = \sin\theta \times$ weight ($\theta = 2.85$) = **92.58 N**

Considering the average speed of 40km/hr (v = 11.11m/s) and the time required for the vehicle to obtain this speed is 8 seconds.

Force required to accelerate to 11.11 m/s in 8 sec. i.e. a = 1.39 m/s

$F_a = 190 * 1.39 =$ **263.625N**

Total Tractive Effort (TTE) $= F_{gr} + F_{rr} + F_d + F_a$

= 92.58 + 13.45 + 7.448 + 263.625 N = **377.103 N**

Total Power = TTE x v

= 377.103 x 11.1 = **4.185 kW**

Hence, we are selecting a **5kW BLDC motor.** ……......(FoS = 1.2)

Battery Selection:

Force required to maintain vehicle at 11.1m/s

F_l = Fgr + Frr + Fd

= 113.478N

Power required = F_l x V

= 113.478 * 11.1

= **1.259kW**

Considering 100Km range at 11.1m/s time required = 2.5hrs.

Therefore, energy required = 1.259*2.5

= **3.149kWh**

Considering losses and low voltage systems battery pack required is **4kWh** ...(FoS 1.2)

Li-ion 18650 battery is being used.

Considering the specifications for Panasonic NCR18650B cells

Nominal Voltage of one cell = 3.6 V

Charging Voltage Voltage of one cell = 4.2 V

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Nominal Capacity = 3350 mAh

Maximum Discharge Current = 1C

III. METHODOLOGY

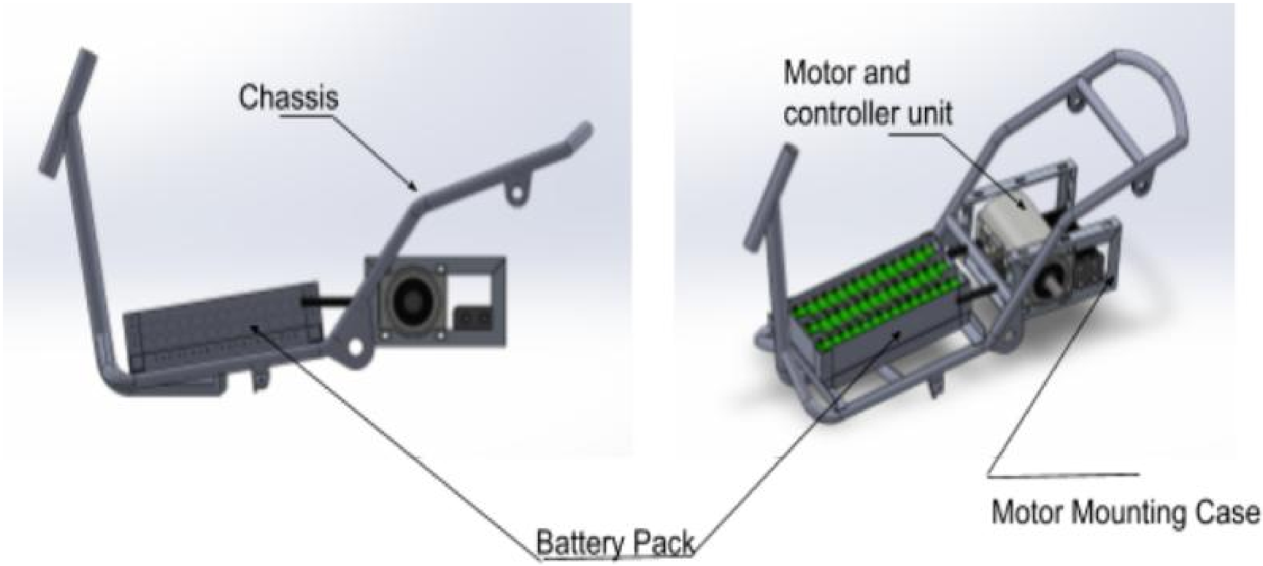

Fig 1: CAD Model of mounting on Activa 5G chassis

3.1 CAD

Activa 5G is well known for its manufacturing quality and chassis overall integrity and strength, hence this moped was chosen for prototype, Since we aren't changing any structural component in chassis, just adding a removable mount for battery pack motor and controller, no extra FEA simulation on chassis is required while motor mounting case and battery mounting brackets.

Motor Mounting Case is a simple cubic structure made of aluminium L channels of 1.5"x1.5" and 0.18" thick. A 5mm thick aluminium plate is used to hold two aluminium rectangular frames together and increase the strength of the case, these all components are machined such that it can be mounted to any vehicle's chassis using nut-bolt connections. Battery pack case is most important as it should be safe enough to sustain mechanical damage in case of accidents as short circuits in battery pack can explode vehicles as well as can cause damage to nearby environment, this case is designed to sustain maximum possible impact.

Motor and Controller unit: These are the main power train units which need to be sized and according to which case is designed so that no substantial damage occurs to the motor and controller, any glitch in the controller can lead to dangerous accidents. When designing the case for this unit, various parameters like, dimensions, weight, rating are considered and the case is designed accordingly

3.2 Components

- *Battery* - The popular battery technologies used in EVs till date are lead-acid, nickel-cadmium, nickel metal hydride, and Lithium-ion (Li-ion) battery. Li-ion battery technology is considered superior to all other battery technologies because of their high operating voltage levels, high energy and power density, wide range of operating temperature, long service life, least self-discharge rate, and absence of the memory effect. Hence We have selected a Lithium-ion battery for our project.
- *Motor* - For attaining high speed and initial torque, brushless dc motor is preferred. Volcano Electric's brushless dc motors offer high performance, long lifetime and low maintenance for applications, with frame length range from 155mm to 331mm. From the calculations and considering the factor of safety the motor with power 5kW is selected.

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- Controller - While motors are mechanically relatively simple, they do require sophisticated control electronics and regulated power supplies. Thus a drive controller is selected which is required to control the motor. The controller choosing for the project must match up with the battery specifications as well as with the motor specifications.

IV. ANALYSIS AND RESULTS

Following model represents a mathematical model of two wheeler EV and graphical outputs of state of charge, distance travelled at constant velocity.

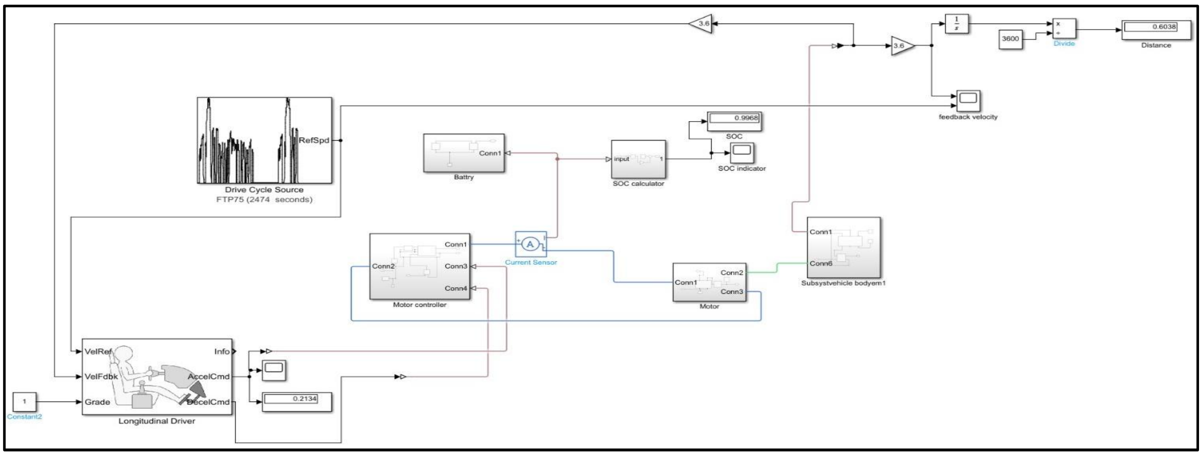

Fig 2: Simulink Model for Electronic powertrain for 2 wheeler 2

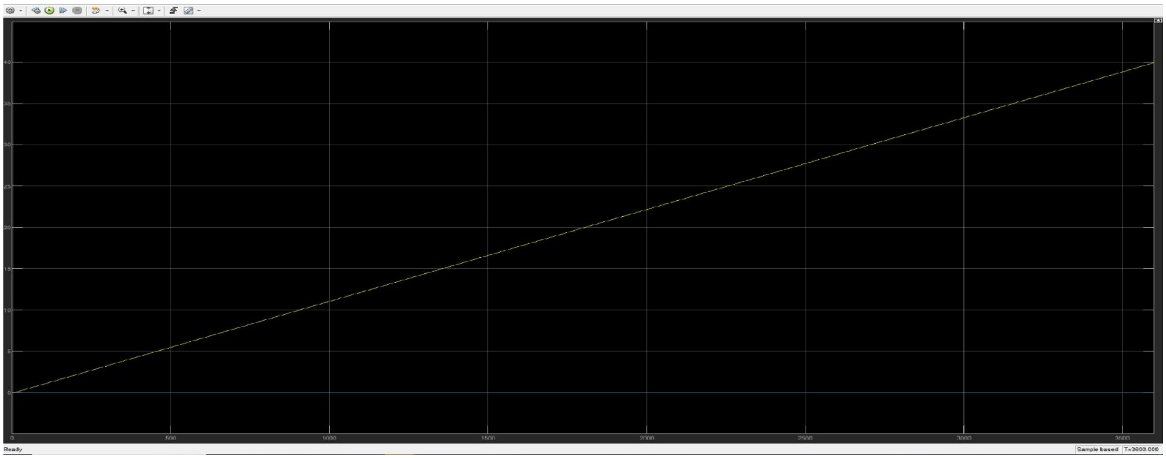

Fig 3: distance travelled at 40 kmph constant velocity

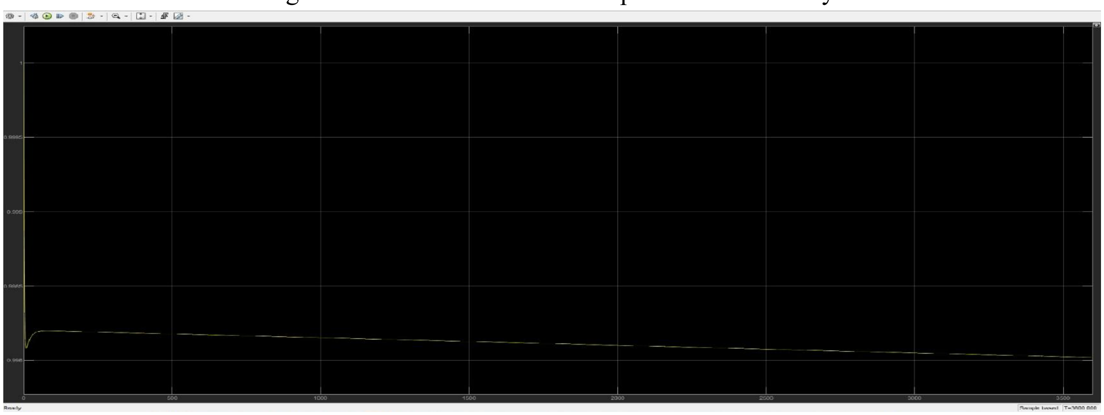

Fig 4: State of charge vs time for 3600 sec

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V. CONCLUSION

The assembly is well suited for all MCWOG category of vehicles. The design is made after taking into consideration the risk factor after the accidents and the test result is the analysis of the vehicle after taking into consideration the real life conditions under normal operating temperatures and the actual range of the vehicle.

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