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Review on Design of Electric Formula Car

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Abstract: ***The aim of our project is the development of an electric F1 car to reduce emission of hazardous pollutant gases and to design and develop a vehicle which works efficiently on electric power. A F1 car is a single-seat, open-cockpit, open-wheel formula racing car with substantial front and rear wings and battery positioned behind the driver, intended to be used in competition at F1 racing events. The engineering behind the design of a safe, rigid and torsional free frame, well-mounted electric powertrain along with the braking, suspension and steering system. We approached our design by considering all possible alternatives for a system and modelling them in SOLIDWORKS. The design process of the vehicle is iterative and is based on various and reverse engineering processes depending upon availability, cost and other such factors. The recent technologies developed helps in reducing the stress and strain while not physical properties within the gift work we have got used Solid-works.***

Keywords: Fabrication, chassis, design, SAE, safety

I. INTRODUCTION

This paper describes the summary of the design of electric formula car complying with the rules and regulations of Student Formula. This promotes the use of new technologies and the practical application to provide the best vehicle performance. The idea of EV first emerged during the 19th century and studies have been ongoing until today. It has now become possible to see electrical, light electrical and hybrid vehicles with EV technology up and running on the roads. Semi-conductor technology and new control methods were developed and improved during the 1990's. Moreover, DC systems started to be replaced by AC systems. Hence, Asynchronous, Synchronous, Brushless Direct Current (BLDC). The wheel suspension is an integral part of every vehicle as well as the hub unit is a device that fills an important role in supporting a car by the wheels, and integrates the bearings and the surrounding components. The major components of the race car include battery pack - rechargeable battery, which includes accumulators and a battery management system. Difficult operating conditions in a racecar require careful approach to battery pack design, from choosing accumulator cells to mathematical modeling. The developed design procedure allows choosing an optimal battery pack design based on given initial parameters. Controller is the electronics package that operates between the batteries and the motor to control the electric vehicle's speed and acceleration. Ackermann Steering system is responsible for giving a quite smooth route which includes a group of parts which is referred to as the steering system which transmits the movement of the steering wheel down the steering shaft in order to move the wheel either left or right. The steering system involves in controlling the car. The steering system of this car is a rack and pinion based steering mechanism that converts the rotational motion generated at the steering wheel into a linear motion at the end of the rack. The design is based on the rule book for SAE SUPRA 2017 and FORMULA BHARAT 2018, according to which drive by wire forbidden and hence we have selected a simple rack and pinion system with no additional electrical or hydraulic help. Though the tracks used for such events are flat in nature, one must account for the natural kinematic behaviour of the steering system and hence it is essential to not only factor the static stress but also the dynamic aspects of the steering system.

II. COMPONENTS

1) *Battery pack*: Lithium-ion batteries are currently used in most electric vehicles because of their high energy per unit mass relative to other electrical energy storage systems. They also have a high power-to-weight ratio, high energy efficiency, good high-temperature performance, & low self-discharge. Research and development are ongoing to reduce the irrelatively high cost, extend their useful life & address safety concerns in regard to overheating. It consists of a battery based on charge & discharge reactions from a combining metal oxide cathode & a graphite anode. Two of more commonly used lithium-ion.

2) *Brushless DC motor:* The idea of EV first emerged during the 19th century and studies have been ongoing until today. It has now become possible to see electrical, light electrical and hybrid vehicles with EV technology up and running on the roads. BLDC motors are considered more energy efficient than brushed DC-motors.

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This means for the same input power, a BLDC motor will convert more electrical power into mechanical power than a brushed motor, mostly due to absence of friction of brushes.

Fig. 1.1 Motor

a) a-rotor
b) b-frame
c) c-wound stator
d) d-integrated to the wheel

3) *Suspension system:* The suspension of F1 car has all of the same components of a road car. Those components include springs, dampers, arms and anti-sway bars. A suspension must be able to take high loads. When an F1 car goes over a kerb at high speeds, the suspension needs to be strong and stiff to be able to handle those loads without occurring any damage. The main purpose of suspension is to connect a car to its wheel. It does not need a complex system of different components because moving a heavy object like a car at high speed creates several challenges. The suspension makes sure the car can handle uneven surfaces; it dissipates the energy that is generated when travelling over undulations and ensures that the grip is spread correctly between the four tires.

Fig.1.2. Rear Suspension Assembly

4) *Hub & Wheel:* In particular, the focus of this project is the creation of a wheel center which was designed and analyzed in FEA on solid-works 2019, after performing fundamental calculations of different loading cases that a wheel can be subjected in a racing competition. The key objectives were to match the requirements of a chosen wheel rim, cooperating with members of the team working on the components to be located inside this wheel and to verify all the dimensions to avoid future issues. Another objective set for the wheel center was a mass below 1 Kg. This was achieved choosing an aluminium alloy 6082-T6 along with weight- saving techniques on the design, which gave a final mass of 861.9 Kg. Among key decisions made during this project, the main one was the choice of using wheel lug bolts and nuts for the attachment of the wheel to the wheel hub, instead of a single wheel nut. This decision proved appropriate at a later stage when it was decided to use the wheel hub from last year's car. A final wheel center model was completed and verified.

5) *Braking System:* The Race car is formula car that is designed around the rules and regulations of the FSAE rulebook, the main aim of this project is to make components light weight and improve their performance. The braking system involves the mathematical calculation of pedal ratio, brake torque, heat generate din brake discs. The brakes must be strong enough to stop the vehicle at a minimum distance in an emergency. The driver must correctly control the vehicle when braking, and the vehicle must not skid. The brake must have good anti-fading performance, that is, its effectiveness should not be reduced under continuous long-term use. The brake should have good anti-wear performance. If there is no braking system, the vehicle will place passengers in an unsafe position. Therefore, all vehicles must have proper braking.

6) *Steering System:* The steering system is a front wheel based steering unit, as it is in most formula student cars. The design involves formation of a mathematical and geometrical model followed by CAD. The approach in designing said system involves the following steps,

a) Identification of the vehicle requirements
b) Geometrical set-up
c) Geometric validation
d) Design of mechanism

III. STUDIES AND FINDINGS

Material selection is based on the application, strength, toughness and machinability. The design of rear suspension was performed in the same way as a design of components of front wheel suspension. In this case the effort was focused on connection and selection of the type, number and connection scheme of battery cells in the pack. Mathematical and computer modeling also useful in the design process of all components and possibility of using already designed assemblies. In order to obtain the optimum volumetric and gravimetric energy characteristics of the pack it is necessary to conduct the calculation.

IV. CONCLUSION

Post thorough validation in terms of structural analysis, forces, meshing, costs resources and most importantly safety the designs were finalized. The design procedure of choosing battery cells for the battery of electric race car, choosing their connection scheme, and calculating parameters of the battery pack was developed. The proposal made in this paper is very extensive and includes the problems of racing car design in knowledge of the rules and basics of vehicle chassis construction. The concept of analysis for design validation is extensively elaborated in this paper.

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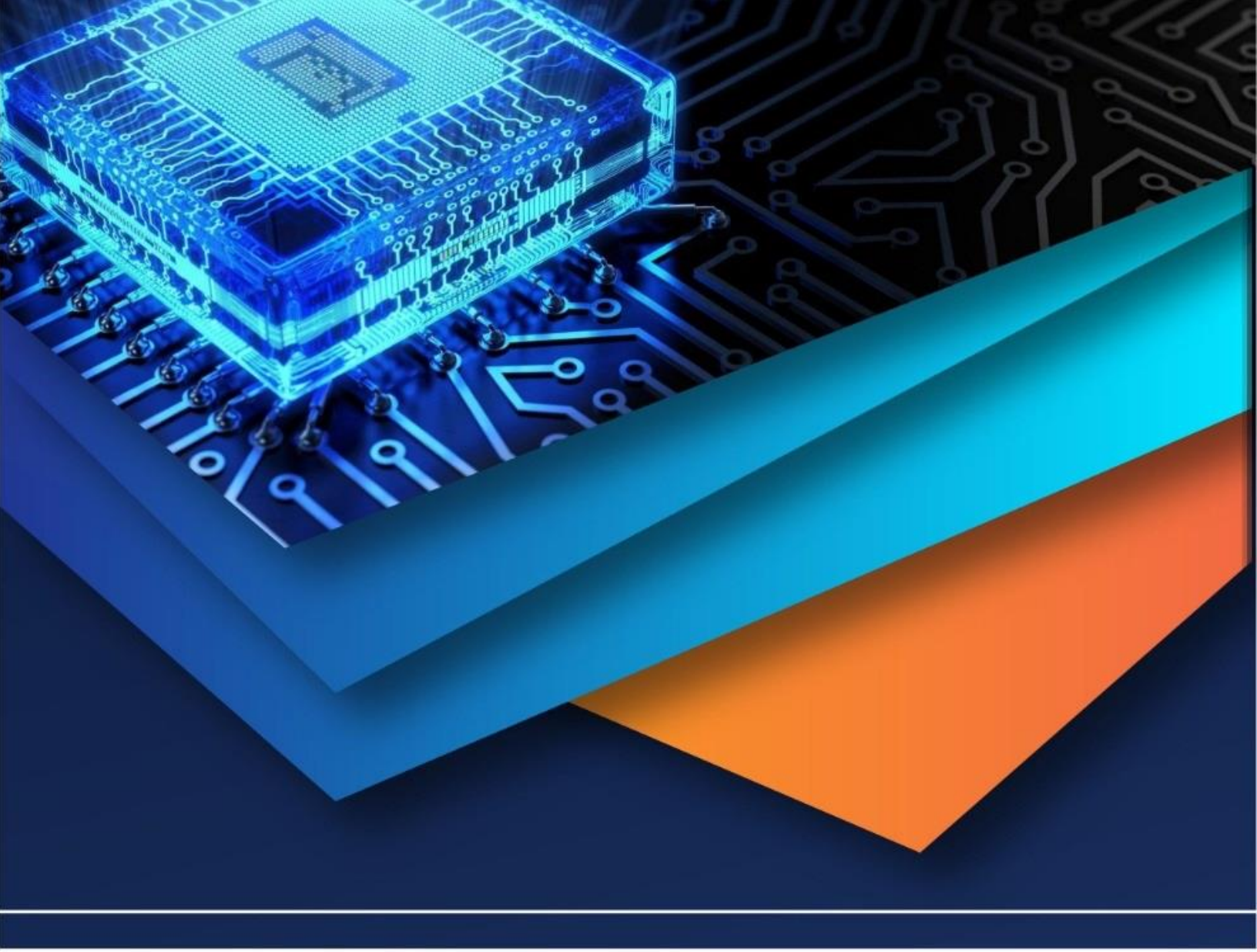

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