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Design and Analysis of Electric Vehicle Conversion Kit

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Abstract: *Development of electric vehicle (EV) conversion process can be implemented in a low- cost and time-saving manner, along with the design of actual components. Model- based system design is employed to systematically compute the power flow of the electric vehicle propulsion and dynamic load. Vehicle specification and driving cycles were the two main inputs for the simulation. As a result, the approach is capable of predicting various EV characteristics and design parameters, such as EV performance, driving range, torque speed characteristics, motor power, and battery power charge/discharge, which are the necessity for the design and sizing selection of the main EV components. Furthermore, drive-by-wire (DBW) ECU function can be employed by means of model- based design to improve drivability. For the current setup, the system components are consisted of actual ECU hardware, electric vehicle models, and control area network (CAN) communication. The EV component and system models are virtually simulated simultaneously in real time. Thus, the EV functionalities are verified corresponding to objective requirements. The current methodology can be employed as rapid design tool for ECU and software development. Same methodology can be illustrated to be used for EV tuning and reliability model test in the future. The conversion process of an internal combustion engine to an electric vehicle powered by batteries comprises many steps from choosing the vehicle, sizing a motor, and the type of batteries. This project takes a 2012 Hero Honda Splendour and converts it to an all-electric Bike with a DC motor and lead acid batteries.*

Keywords: Electric Vehicles, Fossil Fuel, Intelligent Commute, etc.

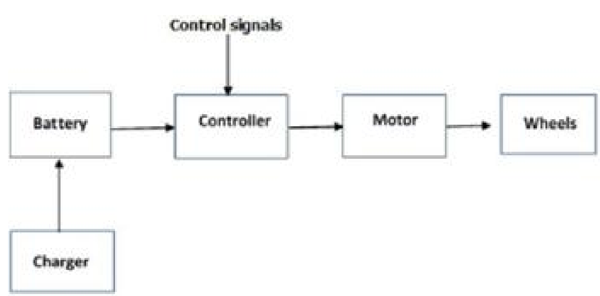
I. Introduction

However, different vehicle models have different technical specifications, so conversion kits for each one of them have to be customized in order to meet the specific requirement such as range per charge and acceleration performance. Therefore, a sub-ECU must be developed to harmonize EV propulsion dynamics and existing vehicle chassis characteristics called drive-by-wire (DBW). To improve EV conversion development process, model-based design process is shown in Figure 1. The method would benefit the design engineer in making better decision for the conversion and also saving time and cost by reducing error during the design process.
The process can be employed to perform system simulation based on different scenarios and technical specification. Virtual prototyping test can be employed to validate design requirement and EV conversion specification.

II. Components

- **A.** The Electric Motor : 60V 2000W HUB MOTOR (17 “)
- **B.** Battery : TATA Green Car Battery, Capacity: 80Ah
- **C.** Controller : 48V/60V/64V/72V 3000W 80A brushless controller

Block Diagram:



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III. Literature Review

Development of conceptual drive-by-wire ECU for electric vehicle conversion (EVC) can be designed by means of a low cost and time saving model-based process. Output obtained from simulation were employed as design criteria to set up drive-by- wire software and ECU hardware functions, which are driving modes, torque set point for EVC electric propulsion in all four quadrants. [3] Developments for innovative systems in engines, hybrid and electrical vehicles are strongly affected by a high pressure on costs, short development cycles and high-quality requirements.

Therefore, within the business unit Powertrain Systems of Bosch Engineering GmbH (BEG) test environments for SW functions in engine control units (ECU) are selected according to cost and efficiency aspects as well as availability. Closed-loop test systems like hardware-in-the-loop systems (HIL) are alternatives to perform system tests of ECUs in a vehicle simulation. At the same time due to these saving effects the number of test systems in an organization can be increased significantly. Test systems like the proposed µLabCar cover a large part of the use cases for testing of systems and software.

[4] The use of automated test tools for automotive ECU development has been increasing in recent years, in particular for software testing, system validation and verification, and regression testing. In this paper, we present a novel framework and toolset which enables maximum test asset re-use in embedded software and control system development. The solution allows engineers to create test cases that are test bench independent, development phase independent, test language independent, and ECU variant independent. In other words, test cases can be created in different scripting languages, parameterized for different ECU variants, and re-used on different hardware platforms or development environments

MiL, SiL or HiL). [5] Hardware-in-the-loop (HIL) simulation is now a standard component in the vehicle development process as a method for testing electronic control unit (ECU) software. HIL simulation is used for all aspects of development, naturally including safety- relevant functions and systems.

This paper describes the role of HIL simulation in the development of safety-relevant systems and the relationships between test methods proposed by ISO 26262 and HIL testing. It explains the requirements defined by ISO 26262 for HIL testing and for HIL systems used in developing safety-relevant systems, and how these requirements can be met. [5]

[6] Electric vehicles are becoming increasingly important as not only do they reduce noise and pollution, but also, they can be used to reduce the dependence of transport on oil – providing that the power is generated from fuels other than oil. Production of zero release of carbon dioxide requires that the energy for electric vehicles is produced from non-fossil-fuel sources such as nuclear and alternative energy. In practice, of course, increasing scarcity will result in huge price rises and eventually the use of oil and other fossil fuels will not be economically viable, hence oil will be conserved as usage will decrease.

Table 1: Cost Table

Sr. No.	Material	Quantity	Amount
1	Bike	1	40,000
2	Controller	1	5,000
3	Battery	4	29,000
4	Hub Motor	1	10,000
5	Harness	1	1,000
6	Assembly	-	1,000
7	Instrument Cluster		4,000
Total			90,000

IV. Design

An electric conversion will act very similar to the vehicle being converted. A small car will be more efficient but can't hold the batteries that a larger vehicle can. The weight of the vehicle will play a pivotal role in deciding what motor to use and whether or not to use direct drive of a transmission. We found a 2012 Hero Honda Splendor on our list that fit our criteria. The vehicle was thoroughly available and being used by most of Indian people in every region of country so the vehicle conversion can easily be succeeded.

It is a Four speed engine which allowed for a smaller motor to be used (Hub Motor required for direct drive). The electronics were simple, curb weight of 109 Kg, and enough room for the batteries.

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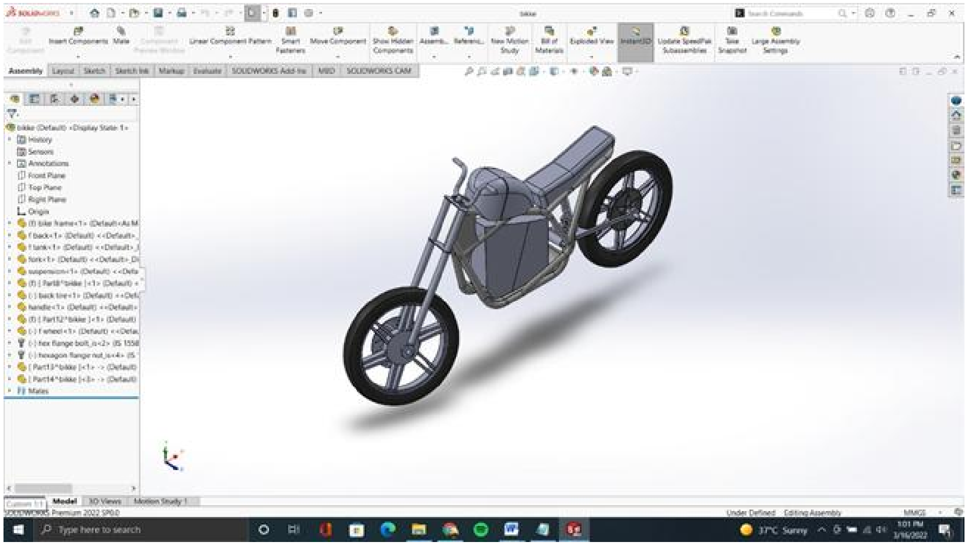

Figure 1: Design of Concept Vehicle

V. Analysis

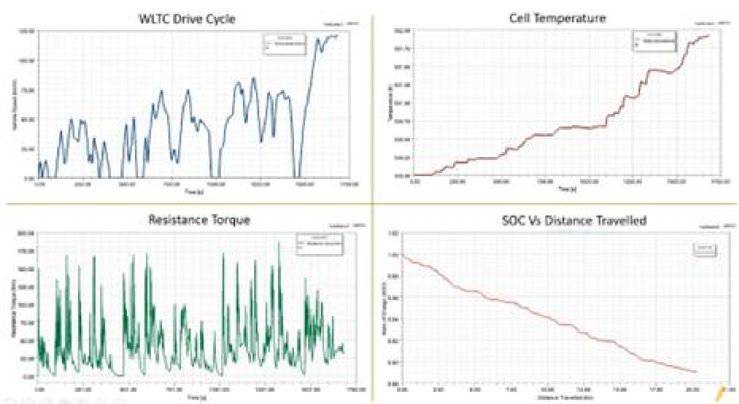

Figure 2: Analysis Results

BRUSHLESS PERMANENT MAGNET DC MOTOR DESIGN

File: Setup1.res

GENERAL DATA

Rated Output Power (kW):	2
Rated Voltage (V):	220
Number of Poles:	4
Given Rated Speed (rpm):	1500
Frictional Loss (W):	2000
Windage Loss (W):	0
Rotor Position:	Inner
Type of Load:	Constant Power
Type of Circuit:	Y3
Lead Angle of Trigger in Elec. Degrees:	0
Trigger Pulse Width in Elec. Degrees:	120
One-Transistor Voltage Drop (V):	2
One-Diode Voltage Drop (V):	2
Operating Temperature (C):	75
Maximum Current for CCC (A):	0
Minimum Current for CCC (A):	0

Figure 1: Analysis Input Data

VI. CONCLUSION

As result, the best choice to decide EV conversion is based on how to choose performance requirement. If conversion is done based on distance, maximum speed should be set first, then the battery capacity. So, the batteries price is 29% of the total cost of conversion. Cost depends on voltage, capacity and types of the battery.

VII. ADVANTAGES

- No fuel required so you save money on fuel.
- Environmentally friendly as they do not emit pollutants.
- Lower maintenance due to an efficient electric motor.
- Better Performance.

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