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Optimization of Electrical Vehicle Parts using Particle Swarm Optimization

K. Gayatri[1], M Suneetha[2]

[1,2]*Asst Professor, Department of Mechanical Engineering, St. Martin's Engineering College, Hyderabad, TS, India*

Abstract- **This paper portrays the Particle Swarm Optimization (PSO) way to deal with style vehicle powertrain segments, (for example, motor force, engine force and battery vitality proficiency) to fulfill all basic exhibition prerequisites like increasing speed, evaluation and most extreme speed necessities and application. The considered Contrasted with customary improvement techniques, PSO handles non-direct limitation streamlining issues all the more effectively and appropriately. The PSAT (Powertrain System Analysis Toolkit) stage utilizes the PHEV powertrain arrangement with fixed-size parts inside the new vehicle model. Reenactment results show that with upgraded segment sizes of PHEV vehicles (by means of PSO), the exhibition and eco-friendliness of the vehicle are frequently altogether improved. The ideal answer for the parts sizes discovered during this examination is expanded execution and vehicle eco-friendliness.**

Index terms- **Powertrain, optimization, PHEV, efficiency**

INTRODUCTION

Plug-in Hybrid Electric Vehicle (PHEV) may be a modified version of HEV during which the vehicle features a relatively large energy storage system (ESS) compared to the HEV, which may be charged from external sources and internal sources like regeneration. Ken. to scale back the utilization of gasoline engines like braking, generators, and to form the foremost of the energy stored within the Energy Storage System (ESS), the energy from the utility grid is employed to recharge the ESS with a plug-in charge capability. Therefore, the plug-in hybrid electric vehicles (PHEV) promises to enhance the vehicle's energy efficiency and reduce environmental costs. Therefore, the plug-in hybrid electric vehicles (PHEV) promises to enhance the vehicle's energy efficiency and reduce environmental costs. Therefore, the look for the optimal configuration of the PHEV powertrain components is that the main essence of this work. The growing importance of this particular sort of combined system has made this field an honest research topic. Therefore, a PSO algorithm was developed to seek out the optimal size of the powertrain components to realize the specified performance goals.

LITERATURE REVIEW

Gengli researched the planning of the powertrain using the adaptive hybrid genomic hybrid algorithm [1] to offer the utmost size of series HEVs. Similarly, Liu relies on the market understanding of how a PHEV should be designed and its electric powertrain, employing a hybrid genetic algorithm looked for the proper size components for the HEV [3]series. But what's needed, also as what's. seems like an alternate conventional / hybrid car, switching from a standard / hybrid car to a fuel-e hybrid centerpiece within the PHEV has little or no change to the electrical powertrain and its performance. This represents the extra cost of small or large PHEV batteries, also because the cost of alittle or large starting powertrain in line with technological change [5]. Most studies specialise in the importance of battery costs. we've shown that powertrain costs are often huge on PHEV's potential, particularly for short-range PHEV. They found that low-powered and cheap, composite PHEVs were preferred over expensive all-electric PHEVs.

MATERIAL AND METHOD

Engine specifications

In general, the characteristics of the used engine model and the baseline component are the 2016 Chevrolet Volt Engine, whose specifications are given by the following instructions:

- 1 × 63 kW (84 hp) Ecoflex LUU I4
- Displacement: 1,398 cc
- Peak power: 51 kW at 4,500 rpm
- Peak Torque: 82 lb.-ft. At 4,200 rpm

Electric motor characteristics

The electric motor may be a secondary electromagnetic unit that gives the foremost efficient operating points within the city by eliminating the inefficient operating areas of the SI engine. This phenomenon is what makes the motor so important. Therefore, the starting points of the motor specifications listed within the following list are important:

- 1 × 111 kW (149 hp)
- 1 × 55 kW (74 hp)
- Permanent magnetic motor / generator

The battery pack used in this optimization research is a relatively large capacity battery pack. The features are listed below:

- Second generation
- 18.4 kWh lithium-ion
- 420 mi (680 km)

The mathematical derivation of those objective function and constraint equations is examined intimately. The overall mathematical expression for the optimization problem is given below.

$$\min_{X\epsilon\Omega} F(\boldsymbol{X}) \qquad \boldsymbol{X} = [P_M, P_E, NBM, FC]^T$$

$$s.t. \quad C_u(\boldsymbol{X}) > 0 \quad u = 1,2,3\ldots,k$$

Where

$X = Column\ vector$

$P_M = Electric\ Motor\ power$

$P_E = Engine\ Power$

$NBM = No{:}\ of\ Battery\ modules$

$FC = Fuel\ Consumption$

Four variables are normalized and weighted to construct the target function. The normalization process is important to bring all the variables to A level because the method requires the addition of the four key variables to at least one level. The subsequent equation refers to the target function**:**

$$F(P_M, P_E, NBM, FC) = w_1\frac{P_M}{P_{M,max}} + w_2\frac{P_E}{P_{E,max}} + w_3\frac{NBM}{NBM_{max}} + w_4\frac{FC_{max}}{FC}$$

Boundary Constraints

Impediments are dictated by the dynamic-condition portrayal of execution prerequisites and style imperatives. The estimations the very pinnacle of size of the three fundamental parts, motor, engine and battery are wont to decide the primary non-straight requirements of the streamlining issue. To shape the parts, as depicted prior, the elements of the drivetrain segments is picked in light of the fact that the intensity of the motor and in this way the engine, and for the office stockpiling framework, the limit is changed over to the measure of battery modules. Every parameter is inspected regarding two classes; One is that as far as possible, that is, the base end and in this manner the other as far as possible, for example the most extreme end. a brisk depiction of how imperatives are taken in arithmetic is portrayed inside the accompanying subsections.

Engine shortage

Average speed can be calculated from the minimum power required by the engine. The following equation represents the minimum engine power.

$$P_{E,min} = \frac{1}{\eta_T}\left(mgfv_1 + {}^1\!/_2\,\rho C_d A v_1{}^3\right)$$

Lack of electric motor

The minimum power of an electric motor to drive a vehicle at a constant speed on a gradient road is represented by the following equation through which the barrier of electric motor power can be calculated:

$$P_{M,min} = mgfv_1\cos\alpha + mgv_1\sin\alpha + {}^1\!/_2\,\rho C_d A v_1{}^3$$

Energy Storage System Constraints

The components are interconnected in terms of their energy requirements. The minimum voltage required of an electric motor determines the least number of battery modules.

$$NBM_{min} = Round\left(\frac{U_{M,min}}{U_{b,min}}\right)$$

SIMULATION

In this research the optimization problem is solved with Matlab using the PSAT tool. an in

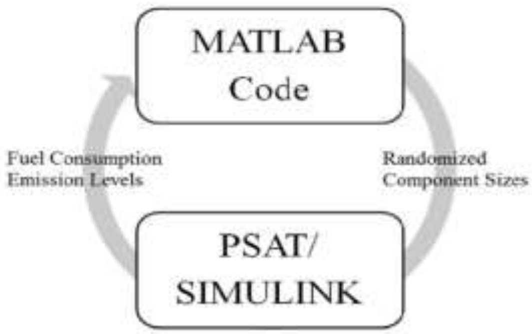

Fig 1: Basic MATLAB correlation Chart

Profundity portrayal of the re-enactment structure of the issue is made and in this manner the outcomes got by the reproduction. the essential segment portrays the PSAT/Simulink displaying engineering and in this way the Matlab content worked for the enhancement instrument, which additionally utilizes the advancement device with the PSAT programming, and hence the subsequent area depicts the recreation results. In the wake of finding the best possible sizes of the segments, the pattern vehicle model and thusly the ideal measured vehicle are thought about as far as execution esteems and fuel utilization. the resulting cycle graph shows the fundamental relationship between's MATlab, PSAT/Simulink [2–4]. The original copy contains the PSO calculation, which initially sends the underlying estimations of the part sizes to the reproduction gadget at that point computes the underlying fuel utilization and discharge level qualities.

RESULTS AND DISCUSSIONS

As a consequence of the reproductions performed inside the PSAT model, fuel utilization and a couple of different parameters are determined. The objective capacity esteem is determined. This circle is persistently rehashed until the cells arrive at the correct arrangement position. Ensuing subsection depicts the advancement issue and subsequently the re-enactment arrangement. The outcomes are introduced inside the second subsection of this area. The basic particular parameters of the vehicle model are appeared inside the table beneath, which is depicted personally inside the issue.

Table 1: Initial Specifications of Powertrain

Component	Model
Generator	52 kW (peak) PM Motor
Energy Storage	5 kWH Li Ion Battery
Motor	50 kW PM Motor
Gearbox	Planetary Gear
Engine	57 kW Engine

The estimations of the limits for the objective capacity factors, which are determined by means of dynamic conditions of the exhibition prerequisites are appeared in Table 2.

Table 2: Boundary values for the constraints

Component	Lower	Upper	Unit
P_M	30	75	kW
P_E	40	85	kW
NBM	6	20	-

Since the most focal point of P/HEV is urban driving, reproductions are directed for five back to back EPA Urban Dynamometer Driving Schedule (UDDS). The UDDS travel cycle is 7.45 miles and 1369 seconds. Table 3 shows the qualities of this specific drive cycle and along these lines the accompanying figure shows the speed (mph) versus time (seconds) plot of a vehicle (speed profile inside the time plot of the UDDS cycle).

Table 3: UDDS cycle characteristics

	Max	Average	Stand. Dev.	Unit
Speed	56.7	19.57	14.69	mph
Acceleration	1.4752	0.505	0.45	m/s^2

The comparison of the component sizes and results in a tabulated in Table 5.

Table 5: Comparison of component size and results

Parameter	PSAT	Optimal	unit
P_M	52	58	kW
P_E	57	51	kW
NBM	7	9	-
FC	103.52	134.78	mpg
CO	0	0	g/mile
NOx	0	0	g/mile
HC	0	0	g/mile
$CO2$	86.2	74.8	g/mile

The default PSAT design recreation results are gotten through five back to back UDDS cycles additionally with the part measures that are resolved in PSAT default.

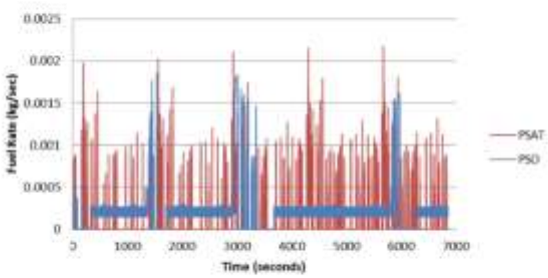

Fig 2: Instantaneous fuel consumption comparison

CONCLUSION

The outcomes show a major improvement in vehicle size of about 30% inside the mileage with the PSO enhancement calculation contrasted with the vehicle's default arrangement. Subsequently, the most target of the examination is to expand the gear. In any case, since the emanation level is estimated after the converter, the contamination outflow esteems are considerably less than to coordinate. The recreation time is very long, constraining the advancement issue to a specific measure of emphases and parameter esteems. Along these lines, for additional refinement of the framework, it's conceivable to expand the measure of rehashes and particles looking at the overall pinnacle of the plan and in this way further improve the arrangement of the PHEV segments.

REFERENCES

[1] Xia, H., Li, T., Wang, B., He, P. et al., "Energy Management Optimization for Plug-In Hybrid Electric Vehicles Based on Real-World Driving Data," SAE Technical Paper 2019-01-0161, 2019

[2] Xiong R, Cao J, Yu Q. Reinforcement learning-based realtime power management for hybrid energy storage system in the plug-in hybrid electric vehicle[J]. applied Energy, 2018, 211:538-548

[3] Sun, C., Sun, F., and He, H., 2017. Investigating adaptiveecms with velocity forecast ability for hybrid electric vehicles. Applied Energy, 185

[4] Bockstette, Jens, et al. "Performance Plus Range: Combined Battery Concept for Plug-In Hybrid Vehicles." SAE International Journal of Alternative Powertrains 2.2013-011525 (2013)

[5] Justin D.K.Bishop, Niall P.D.Martin, Adam M.Boies, " Cost-effectiveness of alternative powertrains for reduced energy use and CO2 emissions in passenger vehicles" Applied Energy Volume 124, 1 July 2014, Pages 44-61

[6] J.García-VillalobosaI.ZamoraaJ.I.San MartínbF .J.Asensiob V.Aperribay, " Plug-in electric vehicles in electric distribution networks: A review of smart charging approaches" Renewable and Sustainable Energy Reviews Volume 38, October 2014, Pages 717-731