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Electric Assisted Hybrid Vehicle

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Abstract: ***This is a concept realised were a fuel driven vehicles can be operated in Parallel Hybrid mode. This will be a continuous parallel operation. Power delivered to the wheels in parallel to the fuel drive is adjustable. Fuel delivered power and Electric delivered power are paralleled at the wheels. Drive Battery for the run is a smaller capacity and can cater few Kilo meters of run. This drive battery is trickle charged with the power and the to the capacity of the engines idling condition and maximum power from the engine survival RPM. This is to counter hampering circulated power draw from the engine. Brakes applied puts the motor in generator mode loading the wheels to charge the drive battery. Motive of this concept is to increase the mileage of fuel driven vehicle.***
Keywords*: IC Engine, Parallel Hybrid EV, Regenerative Braking, BLDC Motor, Engine Survival RPM.*

I. INTRODUCTION

Conventionally Hybrid Electric Vehicles (HEV) [1] is switchable from fuel drive to Electric drive and vice versa. They are independent to each other and operate one at a time. They need heavy drive battery to cater Electric power operation.

The present research results to three types of scopes to assist the fuel driven vehicles.

1) Hub motor on rear wheel of a two wheeler
2) Hub motor on rear wheel of a four wheeler
3) Differential Motor drive of a four wheeler

And on this, vehicle's energy is captured from running of vehicle on fuel into the drive battery in three forms. Each method is unique to its application.

a) Energy capture from Engine survival RPM
b) Disengage engine from wheels to capture down trail energy from wheels to battery.
c) Regenerative energy capture into Super capacitors

Combination of these is done with a fuzzy logic control. Fuzzy logic caters maximum energy storage from engine losses.

II. DISCUSSION

There are kinds of fuel driven vehicles which are targeted to improve their efficiency by way of reducing fuel burn. This research goes towards studying fuel losses and loose fuel burn during run of engine. Two wheelers and four wheelers are considered to make a study and effective remedies are talked upon in this paper. All the approaches taken up here are by converting the vehicles to Parallel Hybrid and with addition of EV components to the engineering of the conventional vehicles without disturbing basic functionality of the vehicle.
The design of add on components are such that Hybrid functionality is disabled by turn off of a switch. Following are the three types of vehicles picked for the experimentation.

III. HUB MOTOR ON REAR WHEEL OF A TWO WHEELER

A petrol fuel driven scooter is taken for the present experiment. Its rear wheel is continuous engaged variator drive. Electric hub motor of the capacity 600W at 48V is coupled to the rear wheel. Wheel is powered with 600W hub motor. Charger power ratings and power delivery to the drive battery are controlled depending on the power draw from the drive battery.

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Fig.1 Two wheeler coupled with hub motor

Fig.1 indicates coupling of hub motor to vehicle rear wheel. This is an approach were electric motor is coupled to the wheel of the vehicle. The engine and motor are operated in Parallel Hybrid and is continuous drive. During Take-off the system puts Engine power is in lead with the motor power. During this condition Energy capture from Engine survival RPM takes place. In this condition Drive battery gets charged from the engine. As the speed increases wheel is moved on to deliver electric power in phase with the engine power. This is
called assisting the engine. In idling condition, too the engine charges the drive battery [2]. Regenerative capture into super capacitor is another approach to tap power from brakes [3]. Super capacitor is good at capturing energy to charge itself and retain charge for longer period. During this period charge can be pumped into the drive battery [4]. Fuzzy logic plays a role in deciding the amount of charge of drive battery and pump accordingly. Fuzzy logic also decides to evacuate the super capacitor after every regenerative braking.

IV. HUB MOTOR ON REAR WHEEL OF A FOUR WHEELER

A fuel driven car is taken for the present experiment. Its rear wheel is free running. Electric hub motor of the capacity 600W at 48V is coupled to both the rear wheels. Electric drive is given from the drive battery which is connected to a fuzzy logic controlled charger on the vehicle starting battery and is in turn connected on to vehicle alternator. Charger power ratings and power delivery to the drive battery are controlled depending on the power draw from the drive battery.

Fig.2 Hub Motor coupled on rear wheel of a four wheeler

Fig.2 indicates coupling of hub motor to vehicle rear wheel hub without disturbing drum brakes engineering. The engine and motor are operated in Parallel Hybrid or Series Hybrid using the gear shifts. During Take-off the system puts Engine power in lead with the motor power. During this condition Energy capture from Engine survival RPM takes place. In this condition Drive battery gets charged from the alternator. As the speed increases wheel is moved on to deliver electric power in phase with the engine power. This is called assisting the engine. In idling condition, too the engine charges the drive battery.
Another approach to save fuel is to disengage engine from wheels to capture down trail energy from wheels to battery [5]. This is automatically done when the engine is in decelerated condition and is running at higher speed than the demand placed on accelerator. This shifts the gear to neutral and puts the hub motors to regenerative mode. The energy thus generated is captured into super capacitors and then pulse pumped into drive battery. Parallel to this since the engine is in idling condition Energy capture from Engine survival RPM is done from the vehicle battery which is in turn from the alternator of vehicle.

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Regenerative capture into super capacitor is another approach to tap power from brakes. During this period, charge is pumped into the drive battery [6]. Fuzzy logic plays a role in deciding the amount of charge of drive battery and pump accordingly. Fuzzy logic also decides to evacuate the super capacitor after every regenerative braking. Fuzzy logic plays a role in capturing maximum energy from the engine survival RPM. Electronic circuitry is used to deliver differential action to the hub motors. RPM of each wheel is monitored and controlled by respective motor controller. Each motor controller has acceleration input which generates the speed demand of each motor. This acceleration input is altered depending on position of each wheel. When the vehicle is running straight both the motors get equal acceleration and once there is any turn speed of one wheel needs to be altered accordingly. This is achieved by employing an electronic circuit to do it.

V. DIFFERENTIAL MOTOR DRIVE OF A FOUR WHEELER

A fuel driven car is taken for the present experiment. Its rear wheel is free running. Electric motor of the capacity 2000W at 48V is coupled to differential. Rear wheels and the hub are removed from the vehicle. Differential is accommodated to drive rear wheels. Electric drive is given from the drive battery which is connected to a fuzzy logic controlled charger on the vehicle starting battery and is in turn connected on to vehicle alternator. Charger power ratings and power delivery to the drive battery are controlled depending on the power draw from the drive battery.

Fig.3 BLDC Motor coupled to Differential and fitted to car rear wheels

Fig.3 indicates BLDC motor coupled to differential of a four wheeler having its own drum brakes. Differential is good for loaders and heavy vehicles like SUVs. The engine and motor are operated in Parallel Hybrid or Series Hybrid automatically selected using the gear shifts. During Take-off the system puts Engine power in lead with the motor power. During this condition Energy capture from Engine survival RPM takes place. In this condition Drive battery gets charged from the alternator. As the speed increases wheel is moved on to deliver electric power in phase with the engine power. This is called assisting the engine. In idling condition, too the engine charges the drive battery.

Another approach to save fuel is to disengage engine from wheels to capture down trail energy from wheels to battery. This is automatically done when the engine is in decelerated condition and is running at higher speed than the demand placed on accelerator. This shifts the gear to neutral and puts the motor to regenerative mode. The energy thus generated is captured into super capacitors and then pulse pumped into drive battery. Parallel to this since the engine is in idling condition Energy capture from Engine survival RPM is done from the vehicle battery which is in turn from the alternator of vehicle.

Regenerative capture into super capacitor is another approach to tap power from brakes. During this period, charge is pumped into the drive battery. Fuzzy logic plays a role in deciding the amount of charge of drive battery and pump accordingly. Fuzzy logic also decides to evacuate the super capacitor after every regenerative braking. Fuzzy logic plays a role in capturing maximum energy from the engine survival RPM.

In actual 2000W of power is not sufficient for rear wheel drive of cars. Most preferred is Parallel HEV to assist the fuel driven engine.

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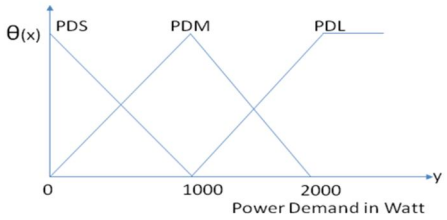
A. Fuzzy Logic of Parallel HEV

1) Power Demand

PDS – Small Demand PDM – Medium Demand PDL– Large Demand {PDS, PDM, PDL}

DefiningPower demand range, Membership Function of the input variables. We use Triangular Membership Functions [7].

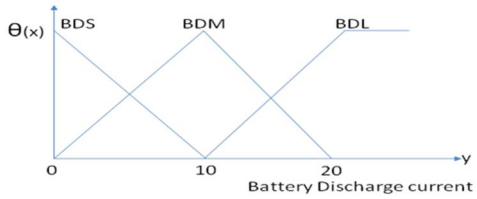


$$\theta_{PDS}(y) = 1000 - y/1000 - 0$$
$$\theta_{PDM}(y) = y - 0/1000 - 0 \ , \ \theta_{PDM}(y) = 2000 - y/2000 - 1000$$
$$\theta_{PDL}(y) = y - 1000/2000 - 1000$$

2) Drive Battery Status

BDS – Small Discharge BDM – Medium Discharge BDL – Large Discharge {BDS, BDM, BDL}

Defining Battery discharge range, Membership Function of the input variables. We use Triangular Membership Functions [8].



$\theta_{BDS}(y) = 10\text{-}y/10\text{-}0$

$\theta_{BDM}(y) = y\text{-}0/10\text{-}0 \ , \theta_{BDM}(y) = 20\text{-}y/20\text{-}10$

$\theta_{BDL}(y) = y\text{-}10/20\text{-}10$

B. Rule Base For Power Delivery To Motor Percentage

BATTERY / POWER	BDS	BDM	BDL
PDS	PVS	PS	PM
PDM	PS	PM	PL
PDL	PM	PL	PVL

VI. PERFORMANCE

Power delivery to the wheels is from two sources and is in parallel configuration. This eases the engine from labouring in certain conditions. This avoids knocking in engine which delivers better life of engine. The motor added on the drive frees the engine from friction. Energy derived from friction losses due to braking are converted to electrical energy and is stored in drive battery is utilised to run the vehicle. These two energies aid the vehicle run effortlessly in Terrine conditions. Fuel consumption was observed to fall drastically in Parallel HEV mode.

VII. CONCLUSION

Fuzzy logic caters a fast and accurate tuning of energy sources. Motors and the engine perform to give a better driving condition, faster pick up and most importantly it saves huge amount of fuel being burnt for its own survival. Efficiency with respect to conventional Hybrid Electric Vehicles is much higher.

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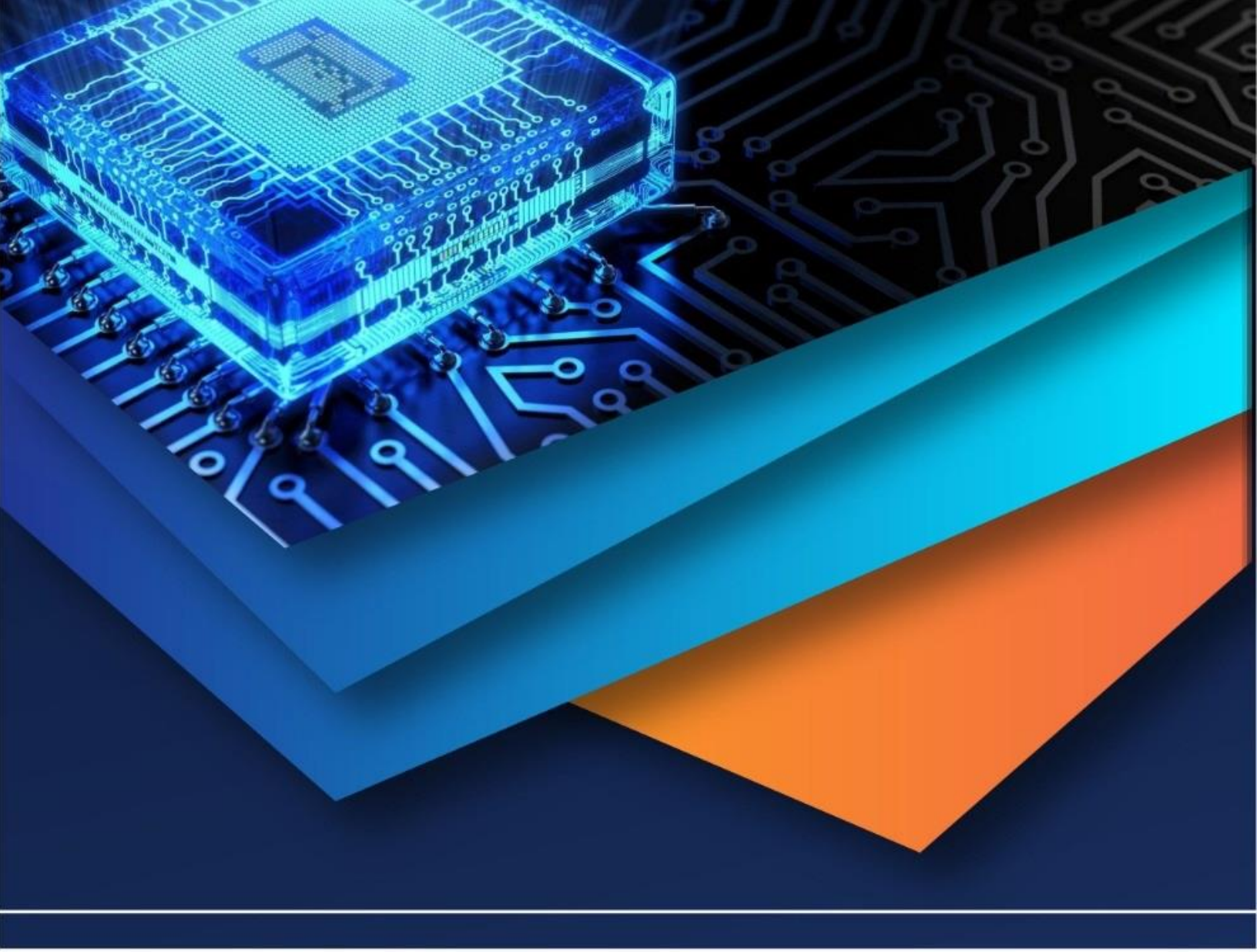

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