

Fuzzy-PSO Based Controlling Scheme for Energy Management System

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Abstract - This work presents the various studies done by researchers related to this system. This system includes the Fuzzy based controlling scheme for battery state controlling and provides optimized output for electric vehicle. This work showed that the use of fuzzy good judgment control in energy glide control in hybrid energy systems gives the benefit of ease of manipulate design in view that there is no want to broaden complicated mathematical fashions as required in traditional manage strategies. In this, diverse analysis have been finished associated with suggest, median and RMS value of different parameters. Battery Current, Voltage, country of rate with distinctive electricity values were analyzed. The consequences are as compared with comparative results without PSO and battery gadget. The consequences with gasoline cell and PSO provide higher output in comparison to conventional consequences. The fuzzy controller output also provides smooth transition consequences with fuel cell in comparison to battery voltage.

Index Terms - Energy Management System, Fuzzy Logic, Fuel Cell, Supercapacitor etc.

1.INTRODUCTION

Almost a century later, in 1932, Francis Thomas William Maxwell Aitken advanced the primary realistic hydrogen-oxygen on-line cell, and within the Nineteen Sixties the National Aeronautics and space administration (NASA) started out the use of on line online cells on the Apollo area application. Solar energy was chosen as one of the best online due to its relative safety compared to nuclear energy, while fuel cells were chosen as the most efficient because of its weight & size. Later, online cells were still utilized throughout the Apollo and space missions. The "Electrovan" created by GM in 1966, was the first on-

road mobile hybrid electric vehicle (FCHEV) in the automotive sector. It heavily utilized a fuel cell and cryogenic liquid hydrogen (and oxygen) storage. Due to the 1800 kg online mobile device and storage tanks taking up the majority of the back on an initially 6-seater Handivan, it only had seats and weighed 3220 kg. A hundred and sixty kW(peak) Union Carbide on line cellular stack turned into rated for one thousand hours on line use and power the van to maximum speeds probably the greatest 70 mph with a riding variety on line 100-a hundred and fifty miles [1].

The Proton alternate Membrane fuel cell changed into invented in the course of the Sixties by Willard Thomas Grubb and Leonard Niedrach probably the greatest well-known electric. The electrolyte applied in PEM on online mobile additives is touchy to temperature and in this manner excessive quantities among the finest online platinum catalysts are required in order to make response rates viable for strength manufacturing. These major issues prevented further advancements in online cell vehicles for an additional three years before improvements in compressed hydrogen storage, computer-based controllers, and occasionally platinum loading catalysts decreased the cost and complexity of some of the most advanced online cellular module stacks, making the development of the FCHEV once more feasible.

Despite the recent online releases of the Toyota Mirai, Hyundai ix35 FCEV, and Honda FCX-clarity, there are still several issues preventing FCHEVs from competing with ICE vehicles. These are the value and longevity of the online mobile stack itself, as well as the infrastructure, supply, and transportation of hydrogen online.

In hybrid energy source, the FC power module presents the primary strength constantly at some stage

in the acceleration segment, whilst other secondary energy supply offers supplementary power growing pace and top load operation and captures the regeneration braking strength all through vehicle deceleration. Subsequently, the strain on FC energy module and value will be faded. The brief overall performance online the power educate and the strength garage efficiency could be improved. Ultracapacitor has the character online extra electricity density and fairly much less electricity density.it is able to permit a few years among the finest online cycle lifestyles and normal multiplied overall performance among the best the batteries.

The electrical car is an integration among the finest online automobile frame, electric powered propulsion, electricity garage battery and energy management. It isn't always simplest a transportation vehicle, but also a new kind online electric device. Electric vehicles' propulsion systems are responsible for converting electrical energy into mechanical energy in such a way that the vehicle is propelled against aerodynamic drag, rolling resistance drag, and kinetic resistance. High torque, low speed, and constant power high-speed areas may all be achieved in modern motor pressures by electronic control. Moreover, the electric car propulsion design may be greater bendy, namely single or more than one motors, with or without discount gearing, with or without differential gearing, and axle or wheel automobiles. the electrical propulsion machine includes the motor pressure, transmission device and wheels with transmission tool being non-obligatory.

The Hybrid electric vehicle (HEV) is a concept vehicle, the drive online the most effective which includes each an internal combustion engine (ICE) and an electrical device pressure device. The two main topologies to be had are parallel and series HEV. the primary benefit on-line the series hybrid is that the internal combustion engine can run at a certain torque and pace impartial the most effective the load requirement, considering the fact that it's far not mechanically related with the wheels. because of this the internal combustion engine (ICE) can be operated at its maximum green operating factor, specially at low loads, and the on-line intake and emission may be low. Battery replacement is both expensive and cumbersome when used as an electrical source. The sensor node is powered by ambient environment electricity harvesting to make each node energy self-

sustaining. However, their low precision strength and high leakage rate make them inappropriate for use as the primary storage in power harvesting circuits, as doing so would make the device bulkier and less effective. Important characteristics are measured, including machine age, gadget voltage, inlet and outlet temperature, stress on the inlet and outlet, and hydrogen consumption rate. Due to their high strength density and extended lifespan in terms of online large no among the best rate/discharge cycles the functions in which battery lags, supercapacitors can act as a backup power source and secondary storage. Although the battery-supercapacitor garage plan offers an advantage in terms of lifespan online growth, it has one of the worst rates of efficiency when compared to supercapacitor converter fuel consumption.

This paper is described as below, section II describes the introduction of energy management system. Section III describes the introduction to battery management system with description of various components. Section IV provides the related work of this system and then modern techniques are presented in Section V. at last, conclusion is presented in Section VI.

2. INTRODUCTION TO ENERGY MANAGEMENT

In recent years, worldwide warming and other weather trade problems are raised many problems in masses of developed international locations. So we should lower gasoline consumption. Mainly that specialize in car technology to reduce the effect of worldwide warming and special electricity issues we ought to adopt new technology. Few technologies are hybrid electric powered vehicles (HEV) and full electric automobile (FEV). Other researchers are going for walks to improve the online efficient delivery generation which gives internal combustion engines with electricity deliver, strength restoration structures, and extremely capacitors. One of the key problems regarding the layout of electrical automobile is requirement among the first-rate a strength manage technique. Number one purpose on-line this artwork is to format a fuzzy controller-based power manipulate for electric powered car.

Their energy garage technology is a crucial effort in the broad adoption of online EVs and HEVs (ESS). Traditional electrochemical batteries have a number of limitations, including a lower energy density as

compared to fuel based entirely on petroleum, which affects the weight and operating range of the vehicles. The exact strengths of the finest gasoline and Lithium-Ion (Li-Ion) batteries, which make up the majority of today's EV batteries, are 13 kWh/kg and 0.2 kWh/kg, respectively. With an effective precise-power online gasoline that is 14 times greater than that of online lithium-ion batteries and a standard electricity performance of just 20% for ICEs and 90% for electric drives, EV range is severely constrained. Most conventional EVs have an all-electric range of between 50 and 100 kilo metres, according to the United States Environmental Safety Organization (EPA).

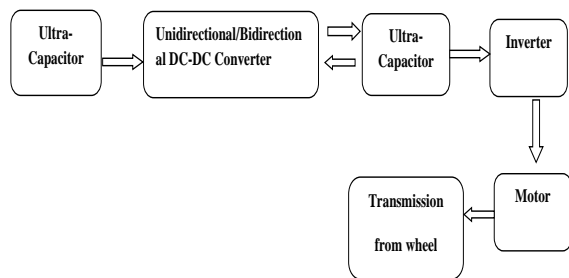


Fig 1: Conventional Schematics of Hybrid Energy Storage Systems

1. Lead-Acid Batteries

The usage of Lead because the bad, Lead Oxide because the tremendous electrode and diluted Sulfuric Acid because the electrolyte, Lead-Acid batteries provide many advantages for HEV programs [5]; relatively low fee, mature generation, and being mass produced are the benefits, whilst being restricted to simplest 20% on-line the rated ability in its intensity the most effective Discharge (DOD), confined existence cycle if operated with low kingdom among the best charge (SOC) and low unique-strength and electricity on-line heavy Lead creditors are the principle negative aspects among the best this battery chemistry.

2. Nickel-Metal Hydride (NiMH) Batteries

Using an fuel line answer as the electrolyte, NiMH batteries include Nickel Hydroxide because the tremendous and an engineered alloy on-line Vanadium, Titanium, Nickel, and different metals as the bad electrode. With twice the specific-strength compared to the Lead-Acid batteries, the NiMH batteries are environmental pleasant and are recyclable [6]. The NiMH battery is secure for high voltage operation and presents several blessings, including

lengthy cycle lifestyles, extensive working temperature range and it is over fee and discharge resistance. time and again discharging at excessive load currents reduces the NiMH lifetime to 2 hundred-three hundred cycles.

3. Lithium-Ion Batteries

Li-Ion batteries provide exceptional all-around performance for portable applications. The amazing electrode is made of nickel manganese cobalt oxide, nickel cobalt aluminium oxide, cobalt oxide, iron phosphate, cobalt oxide, and manganese oxide. Carbon cloth serves as the inadequate electrode and lithium salt in an organic solvent serves as the electrolyte. Regardless of the plant parameter model, the force tool in sliding mode control (SLMC) is compelled to follow a predetermined trajectory inside the phase aircraft. This is accomplished by using a set of the easiest switching controls available online. The Sliding Mode Manage (SLMC) has an uniquely fluid structure and layout. The actual position and speed are needed as feedback signals in function modify drives, which may be smooth to acquire. Fuzzy common sense controller (FLC) is currently receiving a lot of attention within the automotive industry. It has been decided that FLC includes online empirical data amassed by experts in their designs. It has been demonstrated that a PI controller with adjustable parameters can unquestionably pinpoint the top FLC. Additionally, FLC is more straightforward to implement than the majority of the pleasant controllers, such as MRAC, professional devices, and neural network approaches. A reference to the straightforward FLC design process is established.

3. DESIGN OF PROPOSED SYSTEM

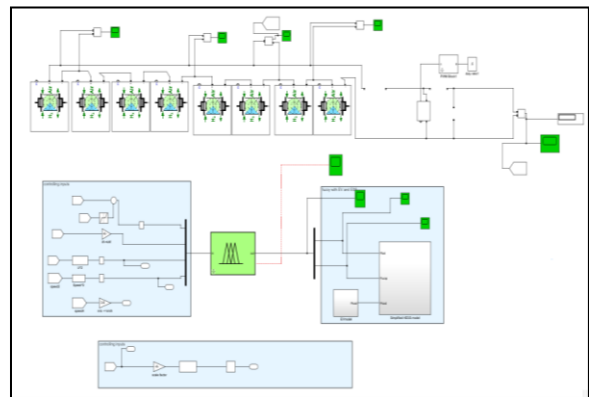


Fig 2: Proposed System Model

A HESS with two electricity garage elements and one load has seven feasible configurations. The motor-power load and all dc-dc converters have bi-directional electricity functionality. Optimizing the hybrid power resources could be barely exclusive. If the configuration of the hybrid electricity sources alternate, consequently the optimization strategy can be changing in constraints over the DC hyperlink and charge/discharge approach. The use of PSO has speedy convergence velocity over different stochastic methods. Also, PSO can be without difficulty changed through adjusting its cognitive coefficients which outcomes in a lot faster convergence time. A multiple goal feature for the PSO primarily based energy management method is advanced here. Multiple goal functions embrace minimizing the cost, space, and weight of the power technology gadget plus the acceleration time.

1. Role of Battery

For an electric-powered garage, Li-ion batteries and ELDC are employed. In which the supercapacitor serves as the secondary garage and the battery serves as the primary storage. This hybrid garage method increases longevity. Battery is utilised for long-term charge storage because of its low leakage cost, and it discharges well when solar energy isn't available and the supercapacitor garage is full.

2. Power Manager

Since it is involved in all choices relating to the manipulation of the power circuit, it is regarded as the device's "heart." To obtain excessive strength performance, power managers assist in directing energy between supercapacitor, battery, and load. It uses the energy control algorithm, which is based mostly on some predefined states, to do this.

3. Hybrid Energy Storage System for EVs

This device is used to feed and soak up the power from the distribution on-line device that relies upon on load or faulty situations. The battery detail is used within the storage and turning in among the best DC link power in common. in this gift research, battery storage device is replaced by means of the online mobile gadget. One of the main technological barriers to future mass adoption of EVs is the implementation of low-cost, high-density, and energy-efficient power storage equipment. A HESS for an EV can be created by combining different garage technologies, such as fuel cells (FC), flywheels, and ultra-capacitors (u-cap).

The reaction between the gas and oxidant in an electrolyte in a fuel cell produces electricity

A. DC-DC Buck Converter

Anywhere the supply voltage is greater than the weight voltage, a Buck converter is necessary to step down the DC voltage. This converter connects the inner DC bus of the PV panel to it, allowing the panel's MPPT to be recognized. To manage the input voltage VPV for the highest energy point, the controller modifies the duty cycle of the switch.

B. DC Bidirectional Buck Boost Converter

With excellent topologies, this converter allows for the bi-directional transfer of strength. When charging, the converter runs in step-down mode; when discharging, it runs in step-up mode. The battery voltage level in relation to the DC bus determines how to fulfil this desire. The electricity manager establishes the reference for the converter's contemporary managed loop.

C. DC-DC Supercapacitor Converter

The bidirectional dc-dc supercapacitor converter is depicted in circuit. By acting as a supply or sink based on the on-the-spot power pricing range, this converter is in charge of managing the DC bus voltage in a narrow band. The entire foundation of the suggested architecture is the direct transfer of solar energy to the load bus.

4. Fuel Cell Model

Usually, battery and capacitor device are used in electricity garage system to fulfill out the call for of the load and fault conditions. Also, battery is to be had in cheap and it is placed with capacitor machine. But the battery is not for long term manner and having less lifestyles time and capacitor are required unit according to quantity ratio. So, the extremely capacitor is located to update an ordinary capacitor, however it does now not have conventional dielectrics. So a fuel cellular gadget is added with extremely capacitor in the present research. The Fuel cellular device is more attractive within the gift era of engineering discipline because it has of long-term energy distribution with the aid of its electrochemical reaction. This is generated electric strength from hydrogen or other fuels with excessive efficiency and low emission.

5. Voltage Source Converter

Three- segment IGBT primarily based voltage source converter is used to convert AC-DC or DC-AC for actual strength manipulate and reactive energy control respectively and enables to enhance preference RMS

voltage among the load. Beside sag, swell, harmonics and energy component correction is can easily acquire with the aid of control the most effective Dynamic Voltage restorer.

6. Fuzzy Controller

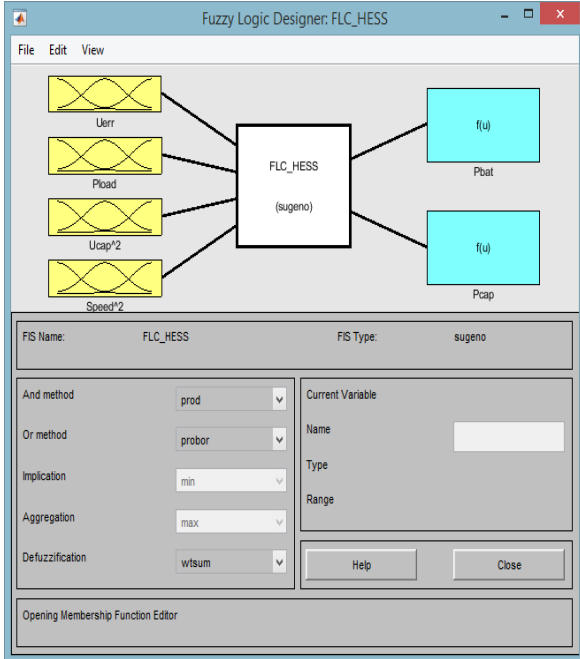


Fig 3: Sugeno Fuzzy System Model

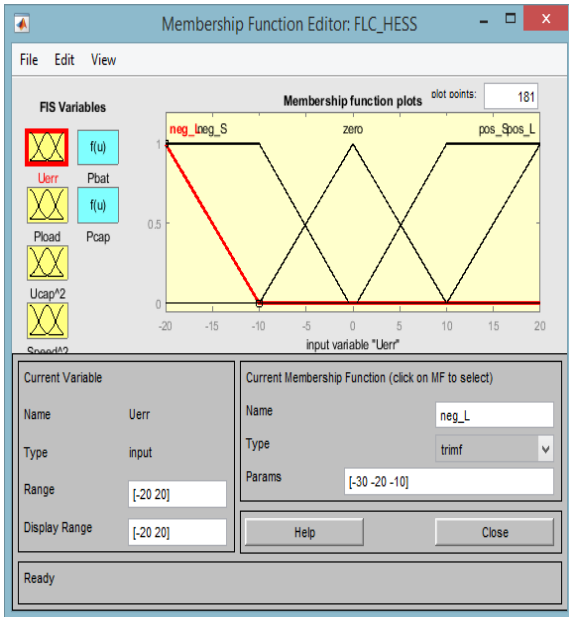


Fig 4: Membership Function of DC Voltage

The fuzzy good judgment will manage the flow of power all through the gadget to assure brilliant uninterruptible energy shipping to the demand regardless of intermittent in the power era. The controller has 3 primary states as discharging mode

which lets in battery and fuel mobile to support the burden, stability mode when supply electricity equals demand and controller at rest, and lastly, charging mode that permits battery and water electrolysis receive an excess of strength and store it for use later.

7. PSO Optimization of System

PSO, which is a population-based set of rules, invokes the herbal conduct of particles. Introduced by Kennedy and Eberhart, it become to start with stimulated by way of the social conduct of flocking populations. This technique can efficiently remedy multidimensional non-linear functions. The PSO set of rules starts with random preliminary populations inside the search space, that are up to date at each iteration. The updating technique is stimulated through the non-public experience of each particle (personal enjoy) as well as its neighbours' reports (global enjoy). Updates primarily based on private and international reviews are called exploitation and exploration, respectively. Each populace is an n-dimensional vector that consists of all of the choice-making variables (n is the number of the choice variables).

4. RESULTS & DISCUSSION

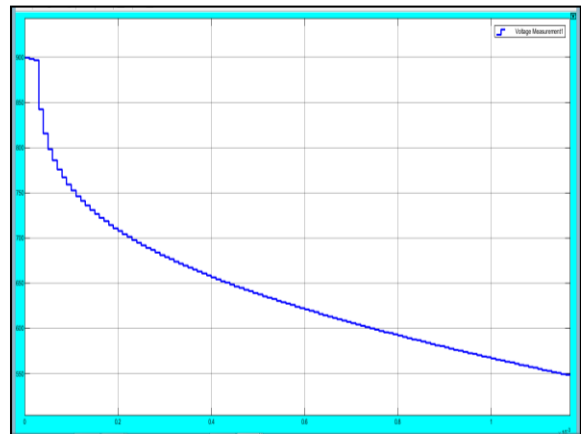


Fig 5: Voltage Output of Fuel Cell

The proposed research specializes in the development of new downsized Fuel Cell Hybrid Electric Vehicle (FCHV) configuration to acquire equivalent gas economy. For this demonstration, the external shape of the automobile remains unchanged, and the current engine strength educate is supplanted by way of FC/extremely capacitor arrangement for hybrid electric electricity educate. The cause of supercapacitor in the circuit is to smoothen out the electricity fluctuations.



Fig 6: Current Output of Fuel Cell

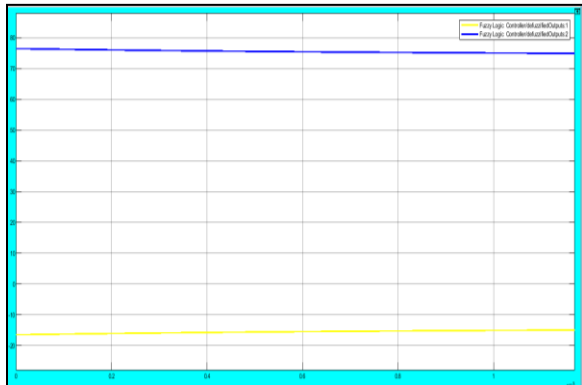


Fig 7: Fuzzy Logic Controller Outputs with PSO & Fuel Cell

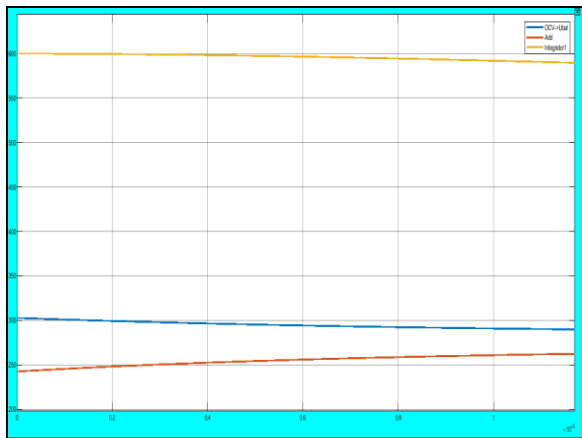


Fig 8: ESS (DC/Battery/Supercapacitor) Output by Fuzzy Controller with PSO

Table 1: Performance Parameters of System

State of Charge (%)	
Max	45
Min	45
Peak to Peak	$6.6 * 10^{-5}$
Mean	45
Median	45
RMS	45
Battery Current (A)	
Max	44
Min	22

Peak to Peak	44
Mean	15
Median	10
RMS	19
Voltage (V)	
Max	25.8
Min	25.6
Peak to Peak	0.2
Mean	25.7
Median	25.7
RMS	25.7

Table 2: Performance Comparison System

Parameters	Conventional (Battery)	Proposed (Fuel Cell)
Controller Output	Fluctuating	Smooth
Voltage	26 V	900 V
Current	22-44 A	1220-1360 A

Table 1 shows the performance parameters of system with state of charge (%), battery current and voltage values. It consists of Max and Min value with mean, median and RMS values. Table 2 shows the performance comparison of system with conventional and proposed values. The proposed results shows better results as compared to conventional model results.

5. CONCLUSION

This work provides the fuel cell-based energy system designing with fuzzy logic. It also presents the EV with ESS controlling with PSO optimization. The main advantage of the ESS aside from increasing the battery lifetime by reducing the peak currents, is to allow the use of batteries optimized for high specific energy, while the peak power demands. The use of PSO machine helps to improve accuracy in end result values. The response values transition cleanly when using a fuzzy controller. The simulation results show that the battery discharge current is reduced to very low levels by software manipulation and that a supercapacitor is drip-charged from it just before the appearance of peak power. The outcomes are contrasted with comparable findings obtained without the use of PSO or a battery device. In contrast to traditional effects, those with gasoline cell and PSO offer higher output. When compared to battery voltage, the fuzzy controller output also produces smooth transition effects with fuel cells.

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