State of art for energy management in Electric Vehicle using Hybrid Energy Sources: A Review

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Abstract: Electrical Vehicle (EVs) have recently attracted considerable attention and so did the development of battery technologies. Although the battery technology has been significantly advanced, the available batteries do not entirely meet the energy demand of EV power consumption. Incorporation of solar panel (PV) and Ultra capacitor (UC) Hybrid Energy Storage System (HESS) a new energy management strategy for HESS and maximize EV drive range. It also reduce the stress on battery during dynamic conditions. This paper represent the state of art for the hybrid energy sources with PV, Battery and Ultra capacitor (UC). The advantage of this setup offer better acceleration performance, longer driving range and controlled regenerative braking. The Bidirectional DC/DC converter is used for proper flow of power to motor during various stage of driving cycle

***Keywords*—Ultra capacitor (UC,) Battery, PV, Bidirectional DC/DC converter.**

I. INTRODUCTION

Our transportation system highly depends on fossil fuels yet because the exhaustion of these asset, interest toward alternative transportation system is growing [1]. Traditionally gasoline and diesel vehicle have lead to many problem such as global warming, environment pollution and exhaustion of petroleum energy. Electric vehicle including pure electric vehicle, hybrid electric vehicle and plug in hybrid electric vehicle are thought to solve these problem [2].Hybrid power supply system is a system in which different type of energy generation have been connected to energy storage system supplying the load at any time. PV is the standout among the best sustainable power sources. Solar energy is most abundant from of renewable energy. It usage has increased considerably in recent time as it has become more feasible and convenient. Power electronic has been playing a major role in this area. Power electronic converter help in converting DC power into AC power. This AC power can then be used for supplying local load or grid [4].The primary energy storage for EV is battery. But due to frequent Charging and discharging, batteries are subject to high power spike and also they cannot satisfy the vehicle demand up to some extent because it possess low specific power, short life and bad performance at low temperature [1].Hybrid energy storage system (HESS) is used as a solution to this problem in which battery is assisted with ultra-capacitor (UC) during transient phase such as starting and braking. To satisfy the high power demand in short period of time an auxiliary sources like super capacitor (UC) is used.

The power density of super capacitor (UC) is high because it can provided thousands of charging and discharging cycle.so by combining the two power sources the operation of the Electric vehicle (EV) can be improved. Generally vehicle operates in 1) motoring mode 2) Regenerative mode. The management of energy become very important task for hybrid energy operated vehicle. Control of power electronic converter play an important role for management in the Hybrid Energy storage system. The use of (HESS) increases the complexity of supply architecture, what needs a reliable management strategy to well govern the system characteristics. In HESS energy management strategy dispatch the power between two storage components [6].the electrical characteristic of unit of hybrid energy storage system i.e. battery and ultra-capacitor they are different from each other. Hence they should not be directly connected across each other other-wise it can cause huge circulating current if voltage gradient exist [10].So to prevent this Bidirectional converter are used [10].

II. SYSTEM DESIGN AND DESCRIPTION

This section describe various parameter used in the Hybrid Energy Storage System (HESS).

A. System description:

Basically the investigated system consist of total three power sources that is PV, Battery and Ultra capacitor(UC) or Super capacitor. Solar and battery is used as primary sources and Ultra capacitor (UC) is used as secondary sources. Solar panel and battery will convey the power when vehicle is running on a plane surface and Ultra capacitor (UC) will provide power when amount of power required is high during a short period of time and recover the energy during braking [1]. Primary sources should be capable of supplying the requirement amount of power to the load in all operating condition for the rating of the input sources should be selected in according to requirement. Boost converter is used to boost the voltage of solar panel. Boost converter convert the low voltage to high voltage. Bidirectional converter is used power flow in both the direction charging and discharging of battery and ultra-capacitor. During motoring mode bidirectional converter will boost the voltage in forward direction and deliver to the load as per requirement and During regenerative mode bidirectional converter send back the power in reverse direction so that state of charge(SOC) will increase this will provide the battery and ultra-capacitor to discharge. H bridge inverter is used to convert the DC power to AC power so that AC power can be used to supply the electric motor. LC filter is used at the end of H bridge inverter to eliminate the effect of harmonic generated after the conversion of DC/AC power. For a certain

load demand we can say that power required for load will be sum of the power delivered by solar panel(P_{pv}),sum of the power delivered by the battery(P_b), sum of the power delivered by the Ultra capacitor(P_{uc}).

$$P = P_{pv} + P_{uc} + P_b \text{ …….. (1)}$$

B. System component and system configuration:

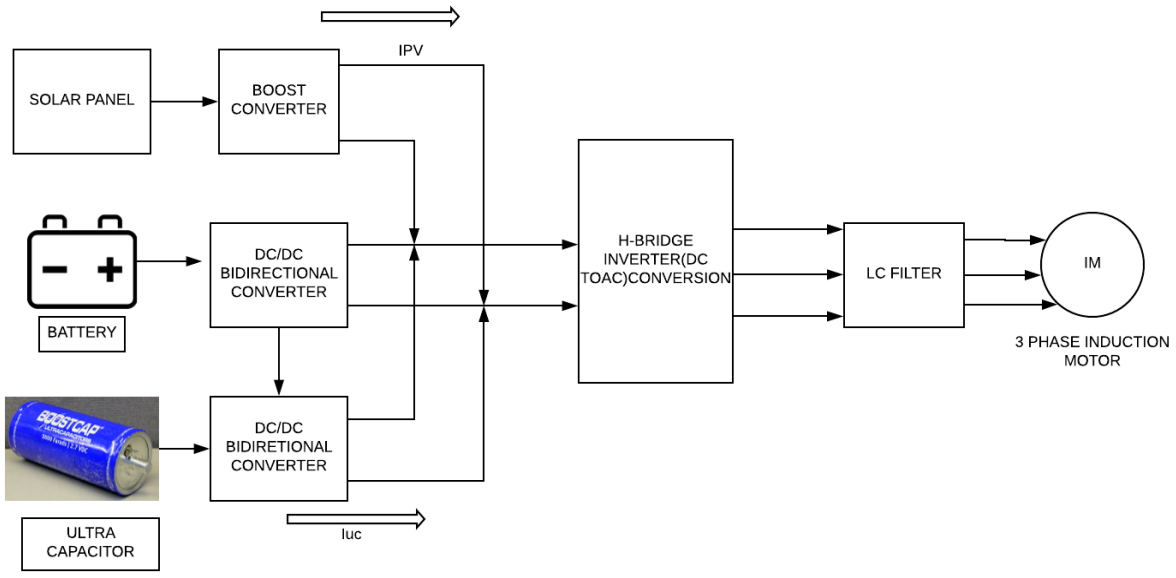

Fig 1. System diagram of the HESS.

This section provides the overview of the component used in the Hybrid Energy Storage System (HESS).

1) Photovoltaic solar panel:

The device which convert direct solar energy to electricity. It is most useful and demandable renewable resource. The solar cell consist of P-N junction type structure. Rating of PV is decided as per requirement and feasibility of available space in the vehicle to mount the same

2) Battery:

We know that the working of battery basically depends on chemical reaction in the battery so charging and discharging takes place. There are different types of batteries available 1) Primary battery: which cannot be recharge again. 2) Secondary battery which can recharge once get discharge. Lithium ion battery, lead acid battery and lead ion battery. So according to the advantage of the battery best one is selected for the process.

3) Ultra-capacitor:

It's also work on chemical reaction but it has fast charging and discharging property.

4) Bidirectional converter:

Use for flow on power in both the direction forward and reverse. Also use to boost and buck the voltage.

5) L C filter:

They are used to remove the harmonic generated after the conversion of voltage DC/AC.

6) H bridge Inverter:

This is used to convert the DC to/AC power conversion for supplying the motor.

III. ENERGY MANAGEMENT STRATEGIES:

The main part of the system is controlling, For working of system effectively energy management is essential Energy management is proposed in two way in literature.

1) By Using Control Loop [2]
2) Rule based Theory[3]

A) By Using Control loop:

In this method controlling loop is divided into two parts low level control loop (LLC) and high level control loop (HLC). LLC

is corresponding to DC/DC converter control and HLC is corresponding to Energy Management Strategy (EMS)

- Low level control Loop:

As we know that LLC is related to DC/DC Converter control so by using constant voltage method we can control the output of the Bidirectional converter the main aim is to control the duty cycle with proper switching of power electronic devices.

Duty Cycle (D) = Ton/T*100.
T = Total time (ON time + OFF time)
Ton= ON time

- High level Control loop:
- HLC is related to Energy Management strategy, in which reference current and Voltage are compare

with each other and according to requirement for motoring and regenerative mode sources will act according to it. Control strategy for PV is Maximum power Point Tracking (MPPT).

B) **Rule based theory:**

A rule based method is very convenient method for energy management, it allows the selection of the sources which should operate to satisfy the power demand by using the three switch which operate as per requirement.
The basic idea of rule base theory is logic that we have to use is artificial algorithms. Flow chart helps us to give proper idea how the rule based theory is used.

The flow chat displayed in fig 2 give the idea about the energy management strategy and also how the rule based technique is processed.

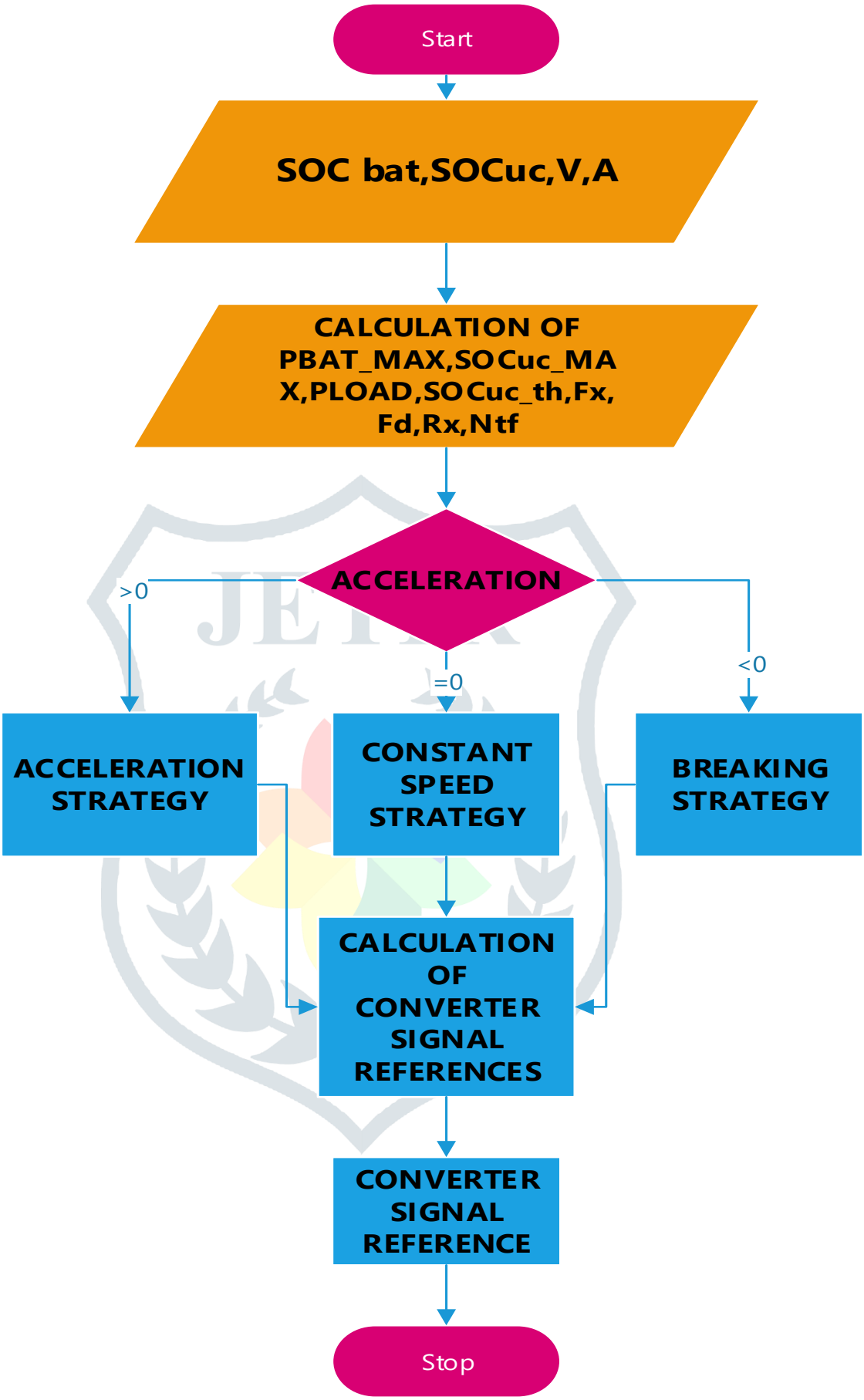

Fig.2 Energy Management System [3]

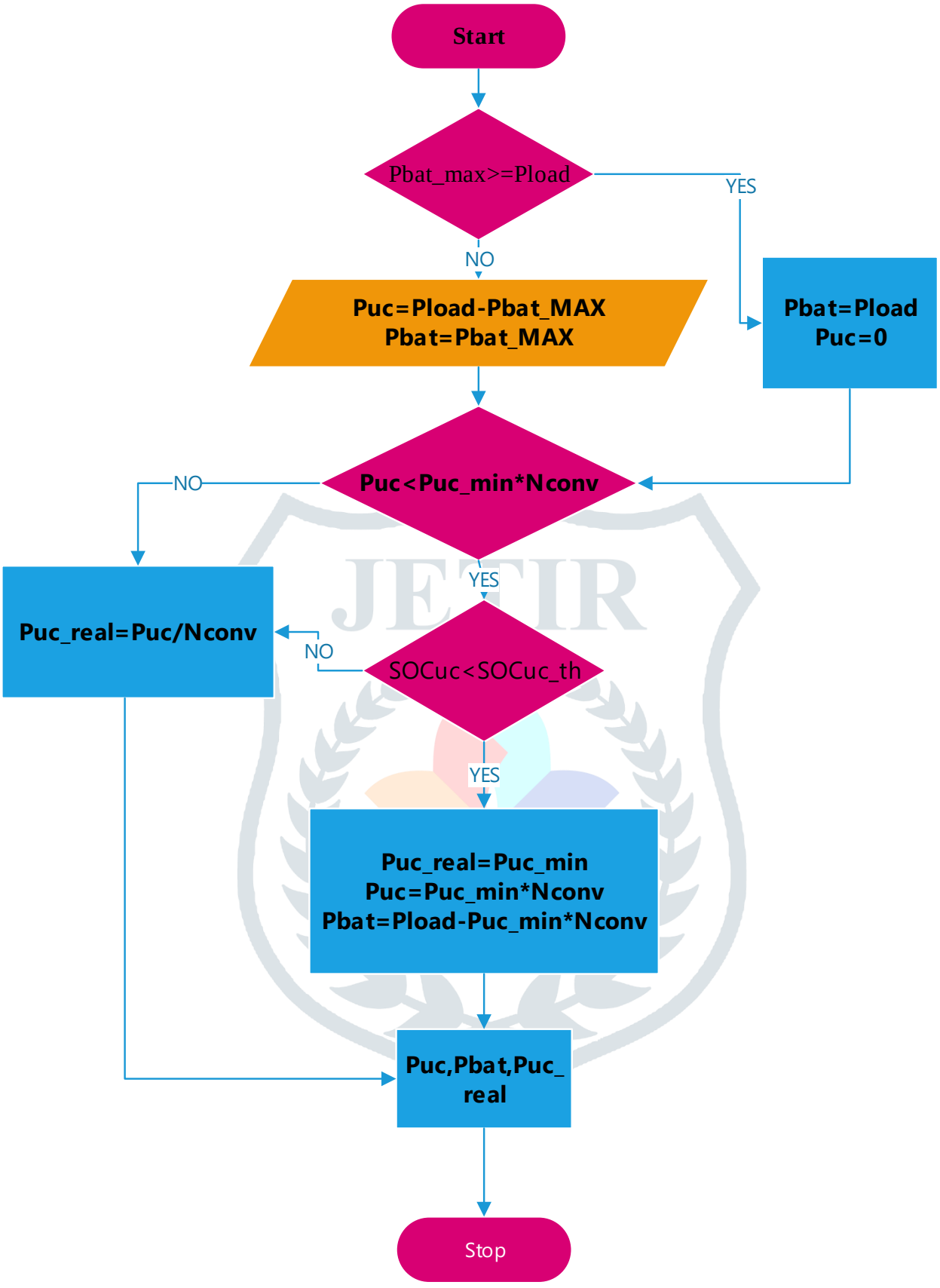

Fig .3 Acceleration Strategy / [3]

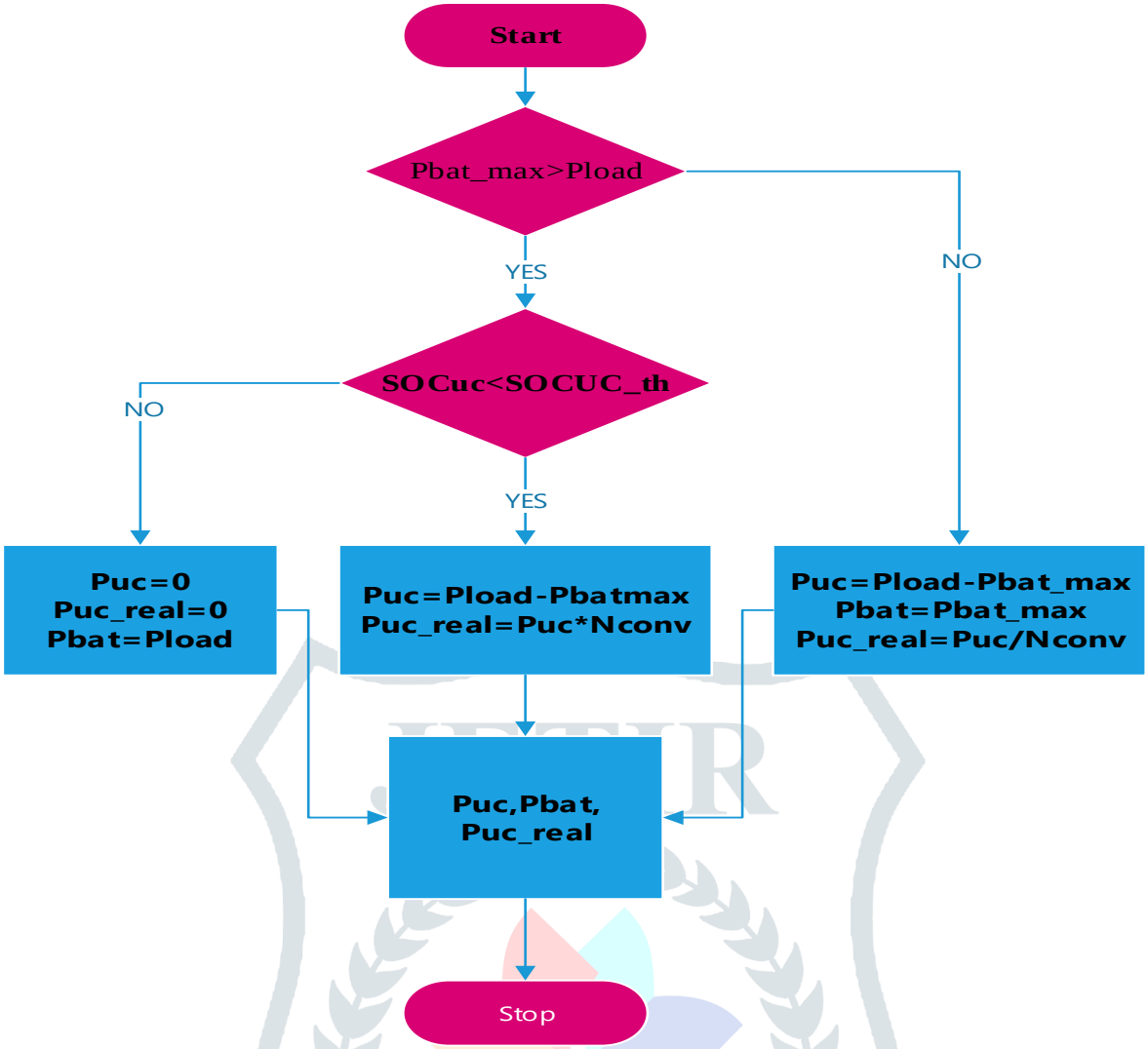

Fig.4 Constant Speed Strategy/[3]

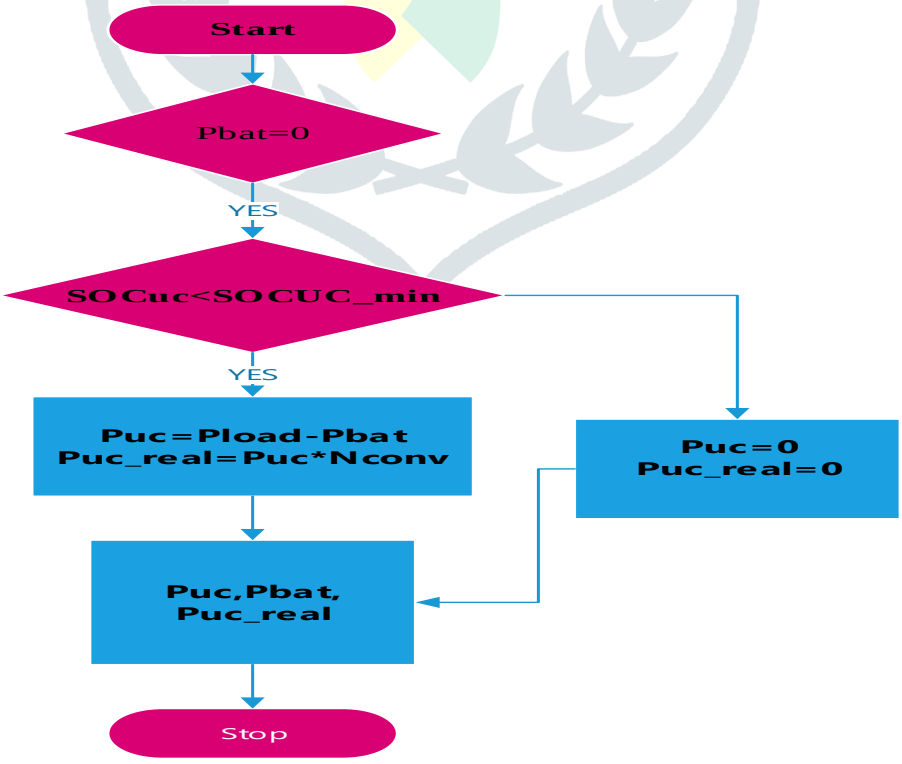

Fig.5 Breaking Strategy / [3]

IV. CONCLUSION:

The system present in this become unique and working become effective due to the use of Ultra capacitor, Due to addition of Ultra capacitor with battery the operating range of battery increase, losses get reduces. Due to addition of Ultra capacitor with battery the operating range of battery increase, losses get reduces. The use of solar energy increase the use Of Green energy, which is beneficial for environment. Ultra capacitor provide large amount of current with short required time, increase driving range of vehicle and due to use of bidirectional converter power can be provided in both the direction. Recharging of battery and ultra-capacitor become fast and efficient.

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