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A Review on Battery Performance Enhancements Using PSO, Fuzzy and ANFIS Controller

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Abstract: In the quest to reduce greenhouse gas and pollutant emissions, electric vehicles (EVs) are positioned as a green alternative to traditional gasoline-powered cars. The widespread adoption of EVs, however, hinges on a significant enhancement in the charging efficiency of Li-ion batteries. The performance of batteries plays a pivotal role in various industries, spanning from portable electronics to electric vehicles and renewable energy sources.

Keywords: EV, Battery, Co2, PSO, Fuzzy.

1. Introduction:

Countries are presently grappling with challenges in establishing new energy systems, spurred by the growing recognition of climate change and the depletion of fossil resources. While expectations point to increases in populations, welfare, and energy consumption, the adverse environmental impacts of human activity need to be curtailed. In 2017, approximately 40 percent and 25 percent of global CO_2 emissions originated from the energy and transportation sectors, respectively. The Paris Agreement, involving nearly 190 nations, serves as a global framework to mitigate climate change and restrict global warming to below 2°C. This concerted effort has directed significant attention and research funding towards technologies like renewable energy and electric vehicles (EVs).

An electric car is defined as a vehicle powered entirely or partially by electricity from an on-board battery. There are various types of EVs, some exclusively powered by electricity, while others also utilize liquid fuels. EVs boast significantly higher efficiency compared to traditional internal combustion engine vehicles. Most EV models require grid power for charging, and there are diverse billing methods available, ranging from basic to sophisticated, with varying timing incentives. Vehicles capable of returning stored power to the grid are termed vehicle-to-grid (V2G) EVs.

For EVs to genuinely reduce emissions, it is imperative that the power for charging comes from renewable sources. Renewable energy technologies encompass biomass, geothermal, hydropower, wind, and solar energy, deployable as dispersed energy producers or centralized power facilities. While solar photovoltaic (PV) technology holds promise in reducing emissions, its integration poses challenges to grid stability due to the erratic nature of these sources. Addressing this requires investments in energy storage and adjustments in energy usage to align with variable generation.

Planning the charging strategy for EVs, balancing energy supply and scheduling, is seen as a hurdle. Charging should aim to minimize costs while ensuring a secure and reliable energy supply, offering benefits such as lower running costs, reduced CO_2 emissions, and improved grid power quality. The synergy of EVs and renewable electricity holds potential for emission reductions in power generation and transportation sectors, with current focus primarily on road transportation.

2. Related Work:

Traditional charging stations pose challenges to the grid's stability, introducing issues such as harmonics, fluctuations, and voltage outages. In contrast, the RCI (Renewable Charging Infrastructure) presents several advantages, including high efficiency, low system cost, and a straightforward arrangement. Moreover, it requires fewer power conversion levels than those in alternating current (AC)-based facilities.

Concerns have been raised about unregulated charging contributing to the overloading of transformers and feeders, leading to potential power supply issues. Consequently, much of the literature suggests the incorporation of stationary energy storage and fast charging systems to address this challenge. Energy storage plays a pivotal role in limiting charging infrastructure costs and operational expenses by supporting electric vehicles during peak load intervals.

Furthermore, energy storage enhances the stability of electric vehicles by providing essential energy for reaching charging stations during emergencies. Numerous studies have explored the advantages of stationary energy storage with fast charging systems. However, realizing these benefits requires optimizing the size of the energy storage system, considering factors such as energy tariffs, expected penetration levels, and EV load profiles.

Fast charging stations (FCSs) emerge as a solution to the crucial issue of charging time, influencing the adoption and deployment of electric vehicles. These stations facilitate rapid recharging, similar to conventional vehicles at gasoline stations, significantly increasing the traveling distance of EVs. The off-board fast charging module, outputting 35 kW, plays a crucial role in fast charging stations. As the current and voltage values are notably high, such infrastructures must be deployed in supervised centers or stations.

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Solar-powered batteries offer a solution to unreliable grid electricity demands, handling strong charge, discharge, and intermittent full-charging periods. Various battery types, including lead-acid, lithium-ion, and flow batteries, fulfill these specific criteria. A central controller is essential for redirecting excess energy produced by photovoltaic systems to the battery.

In the realm of solar converters, photovoltaic arrays integrate with a DC/DC converter for full power point tracking control. The bidirectional AC/DC converter is responsible for converting DC/AC power, facilitating charging of electric vehicles. The converters play unique roles in photovoltaic systems based on balanced energy conversion.

Efforts to reduce exhaust emissions are closely tied to the existence of electric vehicles, particularly in Indonesia, where emissions remain high. Facing this challenge, Indonesia, ranked 33rd in the world in electricity consumption, needs to explore solutions using renewable energy to alleviate concerns related to climate change and pollution.

Solar energy emerges as a promising solution, given Indonesia's vast solar power generation potential of 207.8 GW. Despite the challenges posed by the Covid-19 pandemic, solar energy utilization remains strategic. Global trends indicate increased solar energy development, with falling prices and competitive installation costs making solar energy a promising choice.

The International Energy Agency (IEA) positions solar energy as a major driver in the future growth of renewable energy. Projections by The International Renewable Energy Agency (IRENA) suggest a significant increase in employment opportunities through the production and installation of solar panels, contributing to a diverse job market and business landscape.

In Indonesia, the government has set ambitious targets for solar energy utilization by 2050, aiming for it to become the most significant contributor to renewable energy utilization.

3 Optimization Techniques:

Exploring diverse factual foundations and their comprehension is predominantly reliant on nature. Various techniques and advancements in the current scenario are under examination. Presently, Ira seeks additional concepts for enhancing and ensuring the smooth operation of machinery mechanisms. Aligning with the factual foundations of artificial intelligence necessitates the exploration of heuristic approaches to process data in a factual context.

The types of data under consideration can vary widely, encompassing categories such as literacy rates, educational funding, handicraft materials, and more—the possibilities are vast. To delve into this mechanism, humans must adopt a nature-centric perspective, understanding, enhancing, and drawing inspiration from natural techniques to effectively manage vast amounts of data.

The handling and sampling of this data are not only critical but also crucial for the proper functioning of algorithms and techniques. A comprehensive exploration of possibilities is essential to grasp the scope in an exhaustive manner, particularly considering the autistic approach.

Learning from nature's techniques becomes pivotal in absorbing big data in various situations. This learning process extends to optimization techniques currently in use, each tailored for specific scenarios. These optimization techniques encompass a variety of approaches, which can be categorized as follows:

1. Gravitational Search Algorithm,
2. Central Force Optimization,
3. Simulated Annealing,
4. Black Hole,
5. RayOptimization
6. Small World Optimization
7. GalaxyOptimization
8. HeardOptimization,
9. ParticleSwarm Optimization,
10. BatOptimization,
11. Gorilla Troops Optimization

Data analysis can be categorized based on solution concentration, which falls into two types: single solution-based and population-based. Regarded as the foundation of all research, the single solution-based technique involves analyzing a diverse and extensive database. In this approach, the operating technique selects one entity at a time, performing operations sequentially. While this may consume more time, as the number of entities increases, so does the efficiency of the system.

In contrast, operation-based techniques collect all data and entities, applying techniques comprehensively to the entire structure at once. This structure reflects a more solution-based approach towards nature or non-human activities in the environment. It can be further divided into evolution-based and practical-based measures. Evolution-based techniques involve continuous system upgrades dependent on data, conditions, and rules developed from previous iterations.

On the other hand, physics-based techniques operate according to the conditional zones of entities. These techniques are applied to data with common major factors, which are distinct from each other yet intricately connected. Many techniques rely on a physical and form-based approach.

4. Whale Optimisation:

The Whale Optimization Technique is primarily inspired by the hunting behavior of whales in the ocean. Whales, despite their size, are only able to consume small fishes through their food pipe. Consequently, they engage in hunting schools of small fishes. The hunting process is intriguing, involving the whales diving nearly 20 meters beneath the school of fishes and executing smooth maneuvers in specific loops. These loops are strategically confined to the actual position of the fish school, keeping the fishes unaware of the looming threat until the whale is in close proximity.

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While beneath the school, the whale follows a path to precisely locate the fishes. It continuously revolves around the fish swarm, releasing air bubbles that move upwards, attempting to enclose the school within the bubbles it releases. Gradually, the whale ascends close to the fishes, reducing the diameter of the circle and increasing the rate of air releases. Just before reaching the school, it swiftly grabs all the fishes for its meal, capturing the distinct characteristics of each fish.
Similarly, the optimization technique operates by capturing a comprehensive set of entities that share significant common factors. The data of these entities is aimed to be mostly similar, with a thorough examination of the values of the functional entities being imperative.

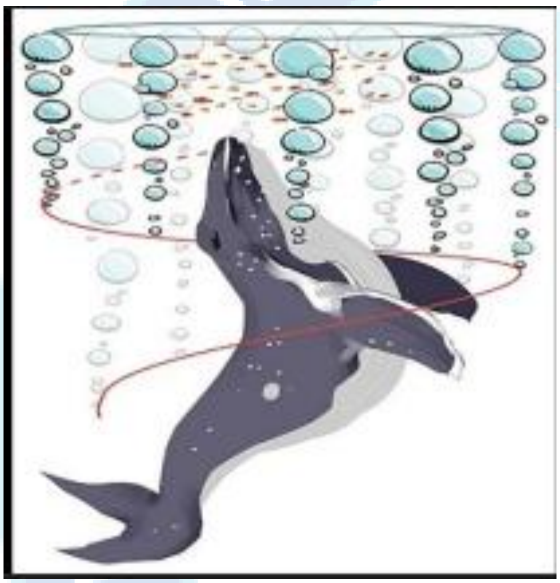

Fig. 1. Whale Optimization

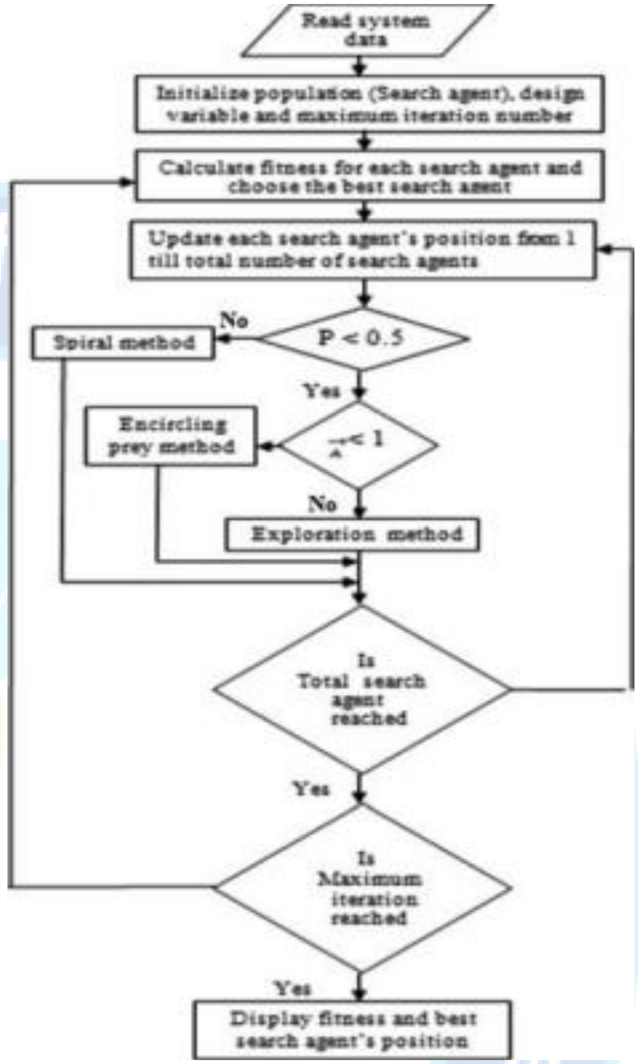

Fig. 2. Algorithm of WOA

5. Fuzzy Logic Controller

A logic controller operates based on the functioning of physical machines or systems, typically being utilized in the control of tangible working machinery. The applications of controllers are diverse, encompassing tasks such as speed control of motors, temperature assessments in deep freezers, and the calibration of light luminosity.

The fundamental components of a fuzzy controller include fuzzification, fuzzy interference system, and defuzzification. Fuzzification involves the utilization of a knowledge dataset already embedded in the system, converting a crisp set of data into a fuzzy set of data. This process is referred to as fuzzification. Conversely, the conversion of a fuzzy dataset back into a crisp set is known as defuzzification.

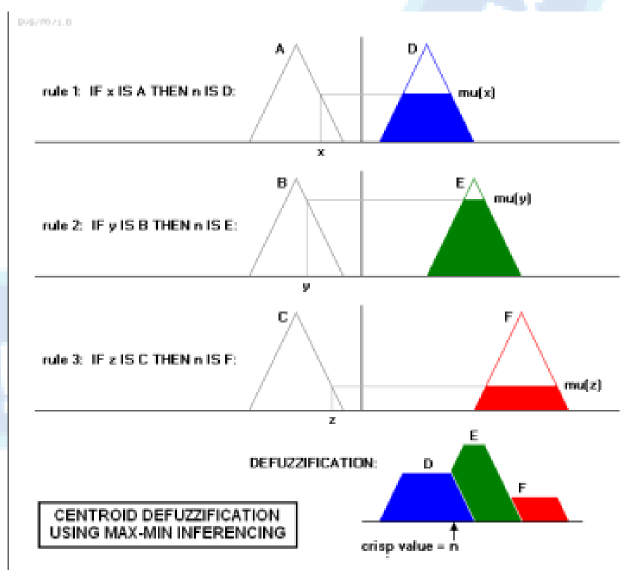

Figure 3.3 Fuzzy System

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Another crucial component in fuzzy logic control is referred to as the membership function. Technically, the membership function represents the value of the specific entity that needs to be controlled or optimized. It serves as the value under our control or analysis through feedback in the process of minimizing errors. For instance, in temperature control, the temperature value of the room would be considered the membership function to be optimized accurately.

6. Conclusion:

An in-depth exploration of hybrid power systems involving PV and electric vehicles has been conducted, emphasizing improved backup capabilities and charging infrastructure for electric vehicles through various optimization techniques.

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