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GREY WOLF OPTIMIZATION IN HYBRID RENEWABLE ENERGY SOURCE GRID-CONNECTED SYSTEM

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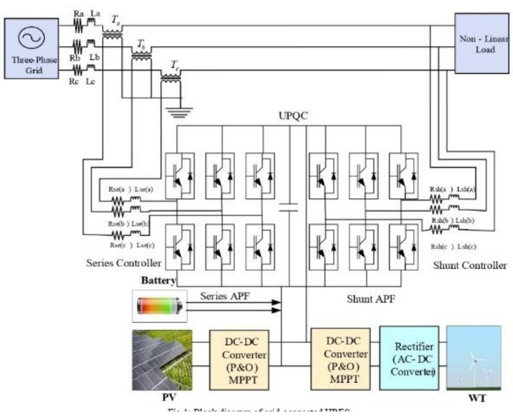
Abstract

The integrated design mainly focuses on power quality (PQ) issues due to the non-linear load condition. Hence this paper proposes the grey wolf optimization (GWO) with unified power quality conditioner (UPQC) to solve the PQ problems in HRES system. The UPQC performance is increased by fractional order proportional integral derivative (FOPID) with GWO. The obtained results indicate that the proposed GWO algorithm has many advantages in various aspects such as early convergence and obtaining optimized fitness value compared to other algorithms like biogeography based optimization (BBO), genetic algorithm (GA), genetic search algorithm (GSA) with existing PI controller. The proposed system is implemented in MATLAB/Simulink platform to validatethe performance during voltage sag, current sag, real power, reactive power and in terms of total harmonic distortions (THD's).

Proposed HRES System with GWO

With the rapid development in industrialization and urbanization, the distribution companies are increased to meetthe energy demand [1]. The generation of electricity from fossil fuels is not enough to compensate for the required demand [2].

Block diagram of grid-connected HRES



Architecture of UPQC

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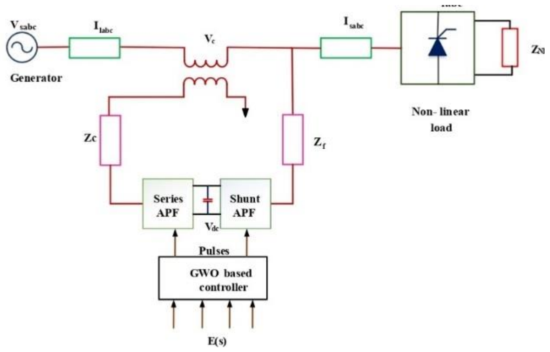
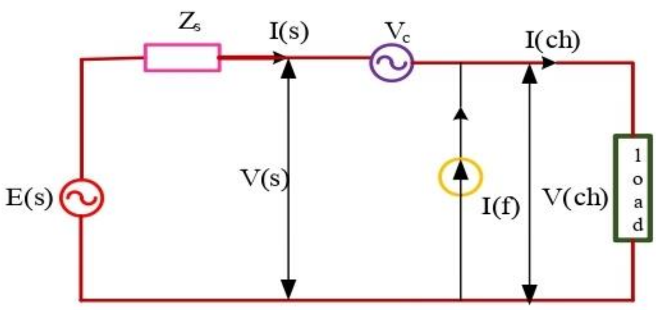


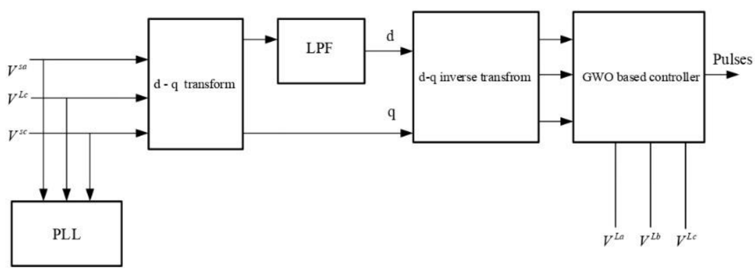
Design Model of UPQC

FACT devices are playing an important role in the power system for the improvement of power quality[3] with the advancement of power electronics [4].In the proposed HRES grid-connected model UPQC design is used to mitigate the PQproblems [5].



CONTROL STRUCTURE OF UPQC: SERIES AND SHUNT ACTIVE POWER FILTER

SERIES ACTIVE POWER FILTER



Shunt active power filter

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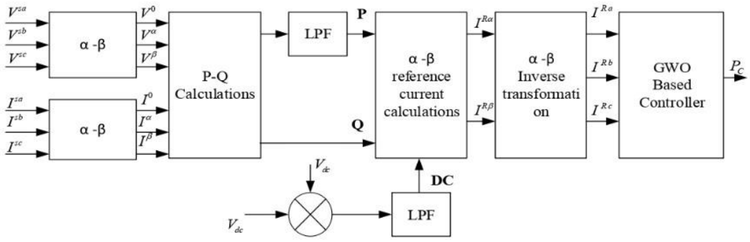

Grey wolf optimization algorithm

Grey wolves are generally called apex predators which means that they are at the top of the food chain [6]. They generallylive in groups on an average size of 5-12 and have a strict social dominant hierarchy [7]. They generally categorized into three levels: First level: Alphas, Second level: Betas, Lowest level: Delta

Alphas: Here the leaders are a male and female who are most responsible to take decisions about hunting, place for shelter when to wake up, and so on [8]. The decision is dictated among the group and sometimes the behaviors of others among the wolf group are also followed by alphas [9]. The rest ofthe wolf acknowledges the alpha by holding their tails down as the alpha is the dominant one. This shows how organized and discipline of the group [10].

Beta: They are the subordinate's wolves that help alpha in decision making or the other activities of the group. They canbe either male/female which is the best candidate in case the alpha wolves die or become very old [11]. In other words, they have to respect alpha and also have command over the lowestlevel and also acts as feedback to the alpha [12].

Delta: They are ranked as the lowest which plays the roleof scapegoat. They are allowed to eat at the last as all otherswere dominant [13]. Even though they are not having individual importance but due to not causing problems they are not lost in the group. Sometimes they are called babysitters in thegroup [14].

FOPID controller:

The basic diagram of FOPID is illustrated in Fig. 7. The errorsignal e (s) helps in producing the control output u(s). FOPIDwith GWO optimization is designed to mitigate the power quality issues of voltage and current fluctuations in the HRESsystem [15]. The control signal of the FOPID controller is mathematically formulated as

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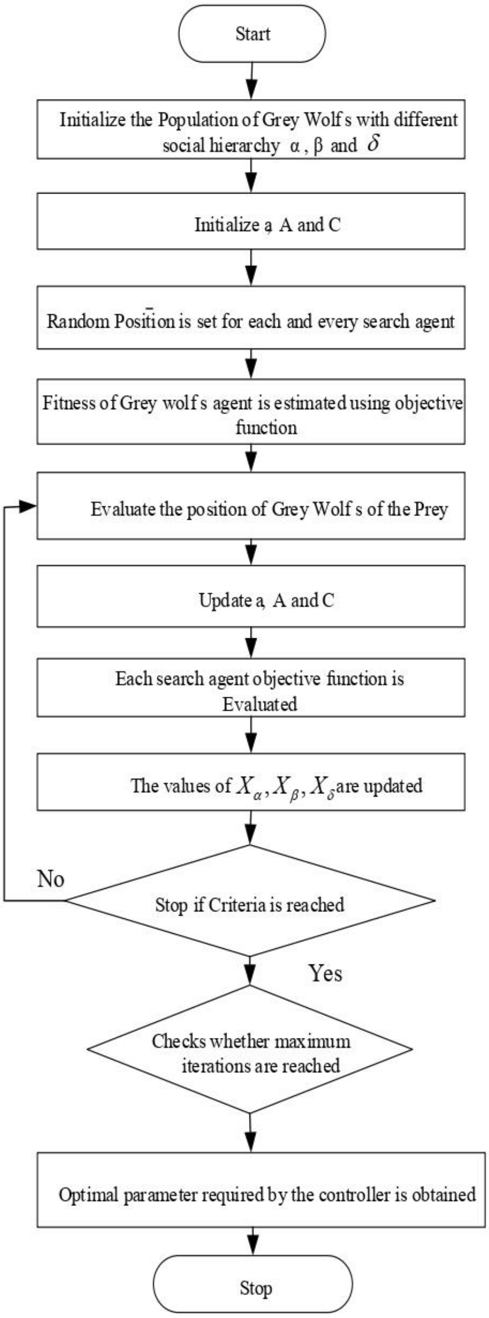

Fractional order proportional integral derivativecontroller

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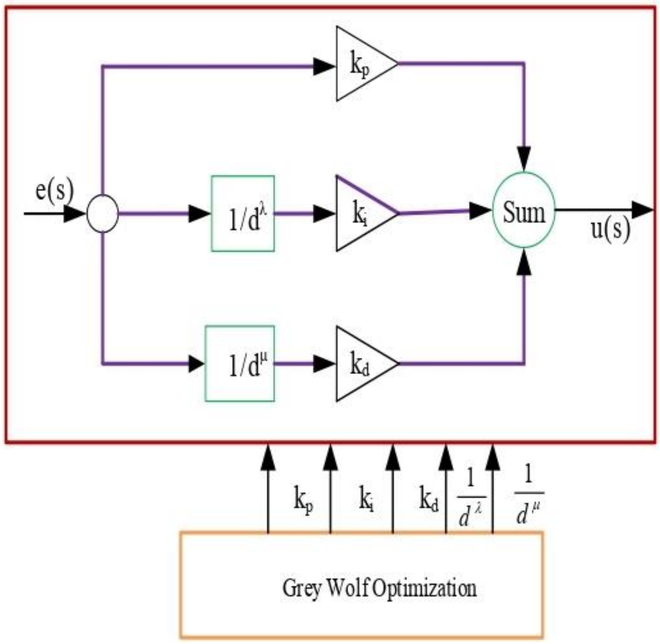

Results and Discussions

Voltage and current sag condition during Non-Linear Load.HRES system performance

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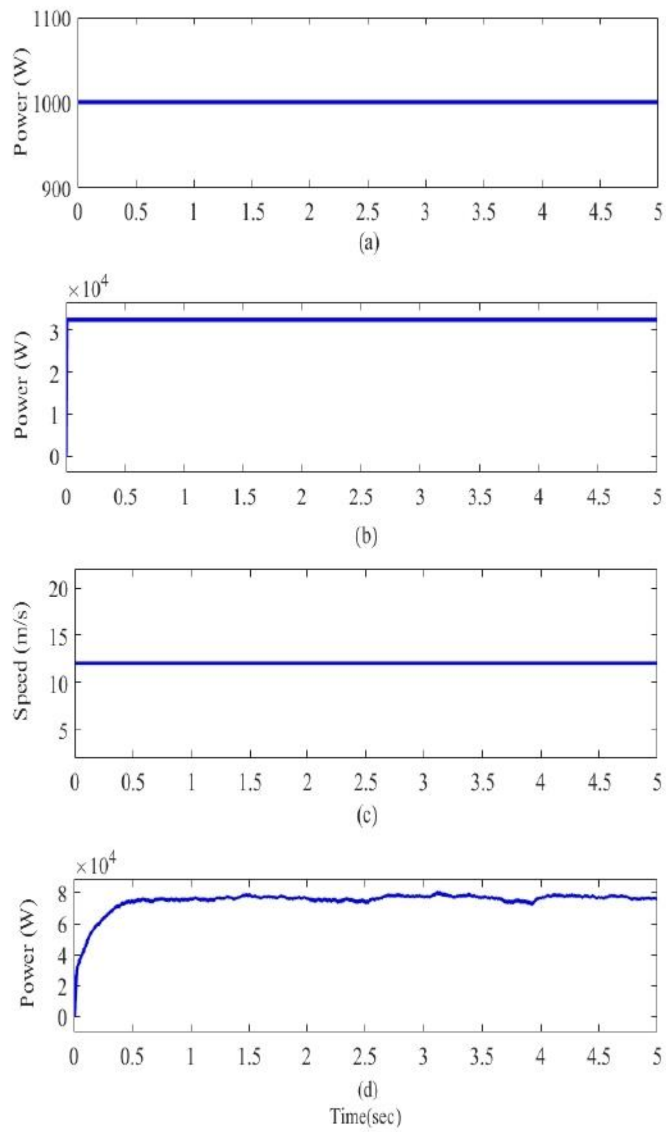
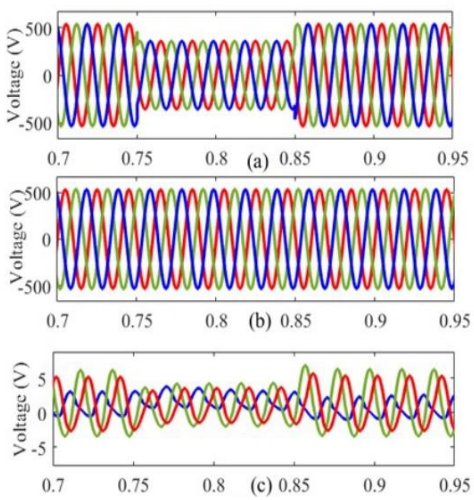


Condition for voltage sag



Condition for current Sag

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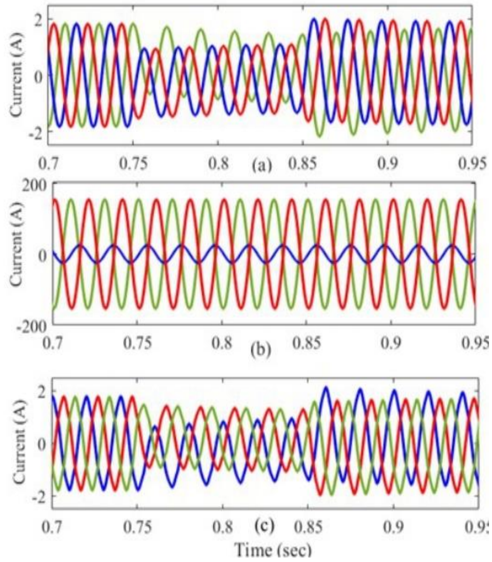
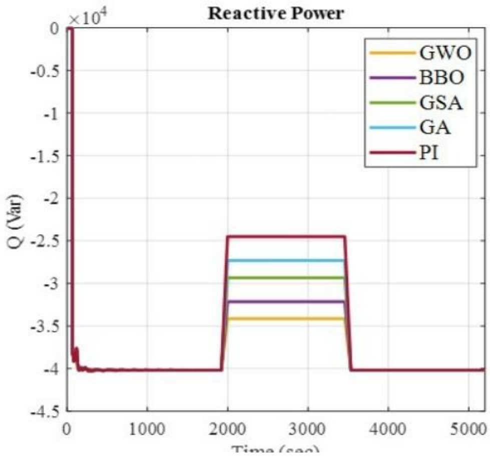
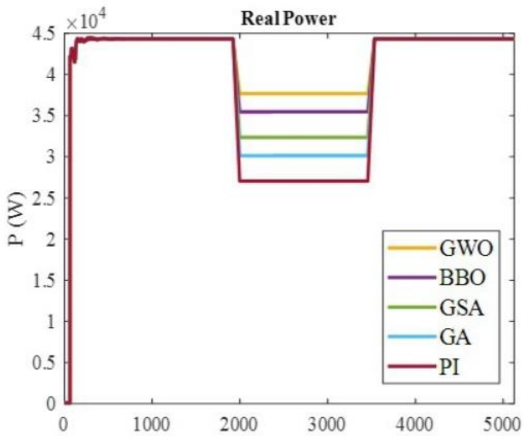


REACTIVE POWER SUPPLIED BY HRES



REAL POWER SUPPLIED BY HRES



Comparison Analysis of THD

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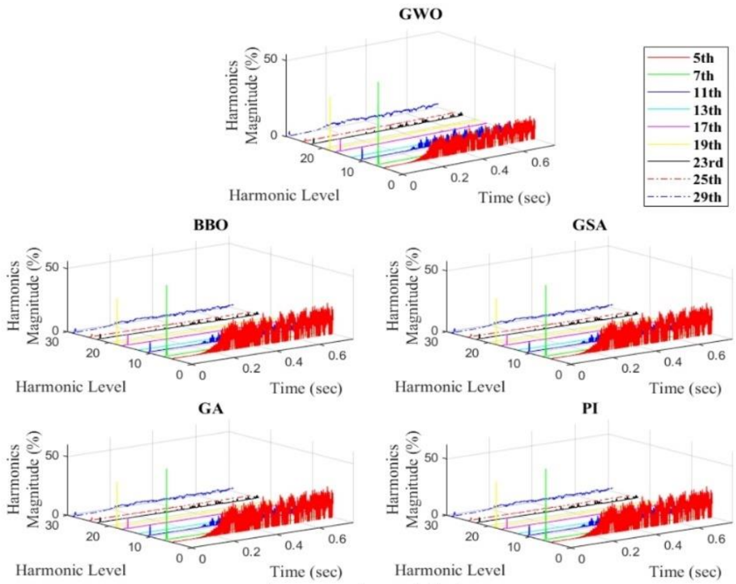

Fig. 13: Comparison Analysis of THD

Conclusion

In order to increase the power quality in a grid-connected hybrid system with battery storage without interfering with the regular operation of real power transfer, a GWO optimization is implemented as a controller for the distributed power system. The GWO is used to construct the ideal set of parameters, and the PI approach is used to forecast the ideal control signals. When compared to other methods, the GWO-FOPID controller produces the best results in terms of THDs by lowering the system's har monic levels.

The MATLAB/Simulink platform is used to design the suggested system.When the sugge sted system's results were compared to those of other current systems including GA, GSA , and BBO with PI controller, it was determined that GWO had generated the best results.

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