Modelling of Hybrid Renewable Energy Production for Base Station

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Abstract:

Cellular access network wants to reduce the power consumption in base station. The power supply system are composed of and wind renewable energy generators and here the charge &discharge scheduling are done by fruit fly algorithm. The input parameters are the calculation of mean and average that multiplied with the shape function which is production in timeframe of a day. This system is the solution of insufficient energy production for base station due to change of weather. These system defines that wind renewable energy for producing more power supply and solar energy harvesting depends on PV size. It gurantee's the sufficient energy production for base station.

Introduction

The phenomenal growth of information and communication technologies (ICTs) has led to an increased energy consumption and resultant greenhouse gas (GHGs) emissions. It is estimated that the global contribution of ICT industry towards CO2 emissions is approximately five percent but expected to grow as global demand for broadband services and computers rises. Amongst all its components, cellular communication is the fastest growing component of the ICT sector. A base station is the most energy consuming element in a cellular network and consumes up to 60% of the network's energy [1,2]. Keeping the current trend, the global number of base stations (BSs) is expected to increase from present (2014) figure of 7.6 million to 11.2 million by year 2020 [1]. In consequence the annual power consumption of cellular BSs will also grow from 84 TWh to 98 TWh by 2020, with business asusual estimates.

The cellular BSs deployed in remote/rural areas resort to expensive diesel generators for meeting their energy needs. An alternate to these conventional energy sources, which are the main causeof harmful GHG emissions, are the renewable energy sources (RES) such as solar and wind energy, which are not only clean but also sustainable [2,3]. A number of feasibilities for RES enabled BS have been prepared using factual site data, as well as simulated data, to configure the size and capacity of wind turbines and photovoltaic (PV) panels [4–7]. These studies strongly recommend the use of RES enabled BS due to economical levelized cost and zero GHG emissions. In [8,9], authors provide a design and optimization framework for green energy enabled mobile networks to reduce the carbon footprint. Renewable energy assisted base station off-loading mechanism with multi-cell cooperation is investigated in [10]. A hybrid energy assisted green multi-cell cooperation is proposed in [11]. The authors propose a greedy decomposition heuristic to reduce grid energy consumption in multi-cell heterogeneous cellular networks. In [12], authors proposed a Markovian model to improve the interaction of a renewable energy assisted green wireless communication network for smart grid applications. A minimum cost solution for solar power assisted LTE macro base station is investigated in [13]. The authors apply CPLEX toolbox to get optimal solution. Modeling of base stations equipped with solar energy and storage units is shown in [14]. In [15], authors analyze the dimensioning of the solar PV panel and energy storage of a grid tied solar assisted hybrid base station. Based on traffic load, authors minimize the total capital and operational cost. In [16], the authors present adaptive algorithms for radio resource management based on traffic forecast in green cellular network. A sleep mode and traffic-based radio resource management scheme for cellular network is investigated in [17].

A BS is well suited for incorporating RES because power generation, storage batteries and the load are all located at one place with minimal transmission losses. Especially for remote sites that enjoy good sunshine and windy conditions, RES offer a good alternative to diesel generators, economically and environmentally. The advancement in technologies related to rechargeable batteries, maximum power point tracker and inverters etc. make it viable to design robust hybrid energy systems [18]. In [5], authors analyzed the feasibility of renewable energy assisted stand alone hybrid GSM BS with diesel generator as a backup. The authors state that a properly designed autonomous wind-solar hybrid system in good sunny and windy location pays off in two to four years, considering the operating and maintenance cost. For a stand alone BS, the solar and wind hybrid system can provide the optimal mix of renewable and non-renewable energy sources. The

design of hybrid energy systems that harvest energy from renewable sources depend on different factors, which are: • The amount of natural energy such as solar-irradiation and wind-speed available at site. • The availability of conventional sources such as diesel generator and grid. • The energy consumption of the system over a period of time. • The energy storage capacity or the size of the battery bank.

Related work

Based on the traffic loads fluctuation, dynamically switching the operation mode of BSs to "on" or "off" is one of the effective ways to minimize the total energy consumption, which has been considered as an emerging and challenging research issue in recent years. To the best of our knowledge, [10] is the first work to study dynamic BS operations and proposed a scheme to switch off some BSs under low traffic load. Marsan et al. [9], [11] proposed some switching strategies for dynamic BS operations based on daily traffic profile. The problem of energy saving with BS switching is a well-known combinatorial problem, which has been proven to be NP-hard [6], [12], [13]. Moreover, solving this kind of problem generally requires a central controller as well as the global information (channel state information and traffic load information), which makes the problem more challenging. Instead of directly probing into this problem, many works [14], [15] adopted fixed switching-off patterns and then analyzed some important quality of service (QoS) metrics (e.g., the call blocking probability and the channel outage probability). In addition, some greedy algorithms have been proposed as in [4], [16]. Son et al. [4] designed a greedy algorithm to achieve the tradeoff between flow-level delay and energy consumption. Kim et al. [16] put forward a greedy algorithm to balance the energy consumption and the revenue in heterogeneous networks composed of cellular networks and wireless local area networks (WLANs). In contrast, distributed schemes for dynamic BS switching operation [6], [17]–[20] are more favored as they do notrequire a wide-area central controller and may demand less information exchange and computational complexity [21]. Furthermore, in the newly approved 3GPP LTE specifications, a flat-system architecture is preferred instead of a traditional hierarchical structure, whereas self-organization and self-optimization capabilities are integrated to avoid failure of single point that often occurs in those centralized controllers [6], [22], [23]. Therefore, a decentralized scheme for BS operations should be designed and implemented for the future cellular communication systems. In [17], Zhou et al. investigated a distributed scheme implemented by mobile devices. However, the proposed distributed algorithm would cause a ping-pong effect. Then, Wong et al. [6] designed a decentralized algorithm implemented by both BSs and mobile devices to avoid the ping-pong effect. Additionally, Oh et al. [18] proposed a distributed and dynamic switching-on/off based energy saving algorithm via a newly introduced notion of network-impact. Guo et al. [19] took into account a distributed self-organizing-network (SON) algorithm to perform dynamic cell expansion through antenna beam tilting. However, all the existing distributed schemes were generally lacking of solid theoretic analysis on the convergence, which presents a great challenge. In [20], the authors developed a actor-critic method based transfer learning framework for BS energy saving, where the BS operations under a variant traffic load were formulated as a Markov decision processes with knowledge transferring. The convergence of the algorithm was established via ordinary differential equation and stochastic approximation theory. Nevertheless, the optimality of the obtained solution cannot be guaranteed.

PROPOSED SYSTEM

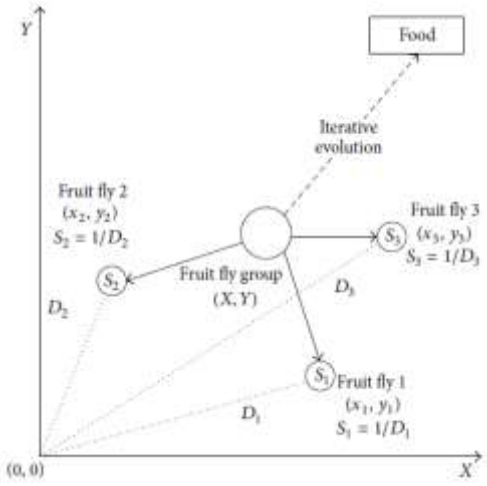
we propose an improved FOA based on the cell communication mechanism (CFOA) by incorporating the information of the global worst, mean, and best solutions into the search strategy to improve the exploitation. A set of numerical experiment results on function optimization shows that the CFOA has excellent global optimization capability and the ability to obtain accurate solution. And its
convergence speed is faster than that of the PSOand the FOA.

Further, we apply the CFOA to optimize the controller for pre-oxidation furnaces in carbon fibers production. Simulation results demonstrate the effectiveness of the CFOA. Carbon fibers are produced mainly from polyacrylonitrile (PAN), pitch, and rayon. Attributing to intrinsic composites, the PAN-based carbon fibers have maintained their dominant position in the market of engineering materials. It has been documented that more than 90% of world's total carbon fibers produced today are made from the PAN precursor. Their high specific modulus and outstanding fatigue characteristics, combined with their lower weight and stiffness, make these fibers attractive for wide applications ranging from sporting goods to engineering components. It is well known that the preoxidation process is one of the most basic and necessary stages in the conversion process fromthe PAN fibers to high specific strength carbon fibers. For example, Young's modulus of carbon fibers can be increased by high temperature treatment. Although

the preoxidation has been widely used in the production line of carbon fibers, it has not been given too much attention and few detailed studies of temperature control are presently available. Wangxi et al. referred to the evolution of structure and properties of the PAN precursors in the process of preoxidation. Yu et al. monitored the processing of pre-oxidation through their experimental results which indicated that the percent of O increases remarkably along with the gradual decrease of C, H, and N. Hou et al. investigated the influence of ozone on chemical reactions during the pre-oxidation process of the PAN as a carbon fiber precursor. Xue et al. investigated the oxygen-induced modification of the PAN-based carbon fibers during the final stage of thermal oxidative stabilization which is used to control the degree of chemical reactions and the radial structural homogeneity of fibers. However, most of the previous work was focused on analyzing the properties of carbon fibers by means of physical or chemical instruments, and little was concerning the control effect of the temperature on preoxidation reactions. Therefore, further studies are very essential from the point of view for improving the properties of carbon fibers in actual product, decreasing the cost wasting in practical production, and increasing the yield of carbon fibers.

The main contributions of this paper include the following aspects: (1)We propose the CFOA, which pushes forward the development of intelligent computing; (2) The CFOA is used to optimize the controller for preoxidation furnaces in carbon fibers production. With the proposed approach, we can control the temperature of preoxidation reactions, reducing not only wasted time but also energy consumption.

Fig. Food searching iterative process of fruit flies.



The Fruit Fly Optimization Algorithm. The FOA is a new swarm intelligentmethod based on fruit fly's foraging behaviors, and it belongs to a kind of interactive evolutionary computation. Fruit flies are very small ones to eat fruit and rotting plants, which widely exist in temperate and tropical climate zones around the world. Fruit flies have visual and olfactory senses better than other species. They can easily make good search of various odors floating in the air with their olfactory organ or even smell the food sources 40 km away from them. Then, they would fly to the food by their sensitive vision.

The food finding process made by the fruit fly can be summarized into the following steps: (1) firstly, smelling the food source by olfactory organ and flying towards that location; (2) secondly, getting close to the food location by their sensitive visions; (3) at last, other fruit flies' flocking location and flying towards that direction. Figure shows the food searching iterative process of fruit fly.

According to the food finding characteristics of fruit fly swarm, the FOA can be divided into seven steps as follows.

Step 1. Parameters initialization: the main parameters of the FOA are the total evolution number, the population size pop, and the initial fruit fly swarm location ($X0$, $Y0$).

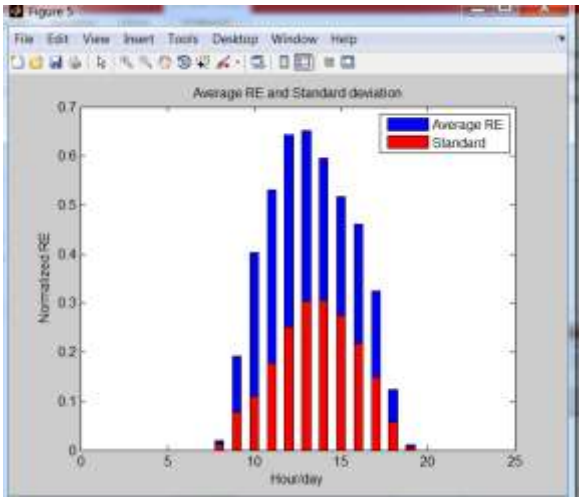
Step 2. Population initialization:
$Xi = X0 + \text{rand}$,
$Yi = Y0 + \text{rand}$.
Step 3. Computation of distance (Di) and smell (Si):
$Di = \sqrt{X2i + Y2i}$,
$Si = 1/Di$

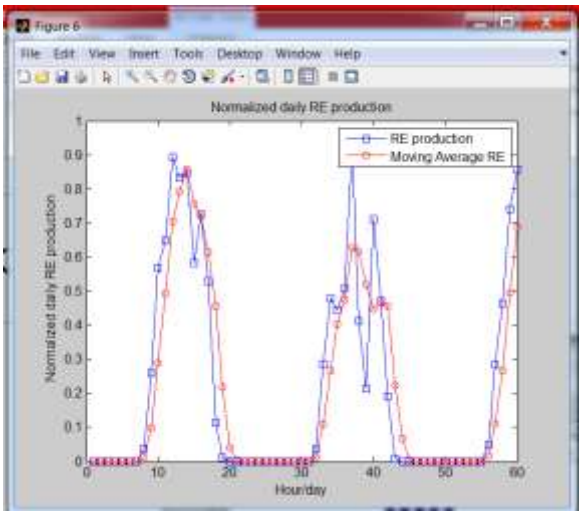
Step 4. Computation of the fitness function (fi):
$fi = f(Si)$.

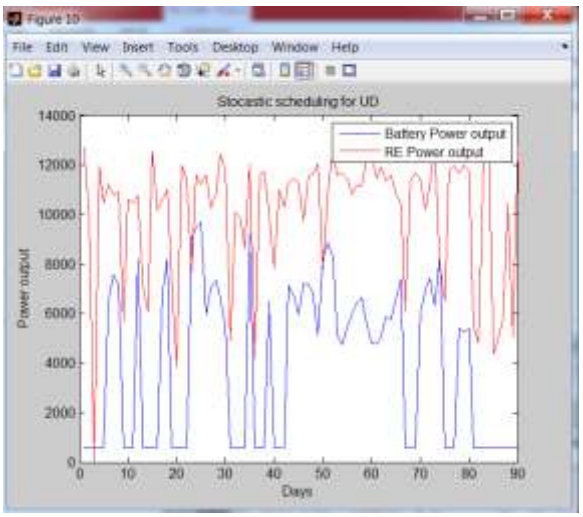
Step 5. Find out the minimum individual fruit fly with the best fitness function (fb) among the fruit fly swarm:
[best$X$bestindex] = min (f (Si)) .

Step 6. Selection operation: keep the best fitness function value and coordinates (Xb, Yb).Then, the fruit fly swarm flies towards that location with the best fitness function value by using vision:
f_b = best$X$,
X_b = (bestindex) ,
Y_b = Y(bestindex) .

Step 7. Judge if the stopping condition is satisfied. If not, go to Step 2; otherwise, stop the circulation.







Conclusion

Recently, there has been growing concern that existing base stations (BSs) without multiple power sources cannot handle power crisis, and thus mobile operators pay great attention to the architecture of sustainable BSs, which leverages renewable energies with an energy storage system .Proposed a simple stochastic model with proper scheduling of charging and discharging where RE production is represented by a shape function multiplied by a random variable, characterized by a mean value and a variance. This random variable characteristics depend on the sun irradiation of the considered location. Our results show that the model is representative of RE production in locations with low intra-day weather variability. Indeed, when considering different distributions of daily production with the same mean and variance, very limited differences can be observed.

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