LOCATION AND DYNAMIC MANAGEMENT OF EV CHARGING STATION USING GWO

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ABSTRACT

The inadequate charging foundation significantly blocks the improvement of the electric vehicle (EV) industry. Instructions to productively send charging stations in a city turn into a pressing issue for the government. Past refueling area models are not appropriate for satisfying the EVs' charging request. This paper proposes a area model for charging stations in light of the attributes of movement ways of behaving of metropolitan inhabitants. The model comprises of two sections: one for brief distance workers which use slow charging (SC) stations, and the other for extremely long explorers which use quick charging (FR) stations. The energy management system, renewable sources and grid are connected with Electric vehicle charging station. The energy management system control and regulates the system performance, electricity demand and supply. The Renewable Energy Sources (RES) based charging station offer helping hand to the location of charging station to meet the changing demands of the EVs. For generation scheduling and economic dispatch of the supply to charging station in this paper proposed Grey Wolf Optization technic to reduce the losses. The GWO algorithm is very promising and has a large potential to apply a renewable system.

1. Introduction

Urban environment pollution and energy shortage are becoming increasingly severe, governments and automobile enterprises consider new technologies to solve the problem. Electric vehicles (EV) as a promising transportation tool are energy efficient, almost noiseless and pollution-free (Eggers and Eggers, 2011). However, EVs depends on batteries of which the technology of capacities and charging speed evolve slowly. EVs cannot be recharged timely in the current circumstance, which will hardly satisfy travel demands of urban residents (Schroeder and Traber, 2012). Studies have shown that the lack of charging stations has become one of the most crucial obstacles faced by EVs when they compare with regular motor vehicles in a analogical range and safety awareness (Melendez and Milbrandt, 2006 a, b; Melendez et al., 2007). Thus, to foster the use of EVs, how to appropriately deploy charging infrastructure becomes an important issue for stakeholders.

This study locates electric vehicle charging and recharging stations according to the two types of travel demands of local residents. The rest part of the work's framework is arranged as follows. In section 2, we propose a formulation locating the electric vehicle charging and recharging stations. For section 3, this paper applies the GWO algorithm for scheduling and economic dispatch to a Charging station. The last part puts forward a discussion of the results and conclusions on this work.

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2. Literature Review

Location problem belongs to the ancient and classic problem. Location theory was firstly introduced by Alfred Weber(Brandeau, 1989). Later, Hakimi proposed p-center location model and p-median location model in 1964. The set-coverage location model (SCLM) was proposed by Toregas(1971). Church (1974) presented the maximum-coverage location model (MCLM). These location problems are regarded as the fundamental location problems and are applied to discrete network facilities location, such as factory, warehouse, station, etc. However, researchers found that some location problems cannot be solved by existing models, because refueling demands not only aggregate on fixed nodes but also emerge in the form of traffic flows when going through the network (Hodgson, 1990). To consider flow-based refueling demand type, Hodgson (1990) formulated a flow-capturing location model (FCLM) on the basis of the maximum coverage. The model sets up p facilities with a view to maximizing the capture of the passing flows. This work was later extended by Hodgson and Rosing (1992), which contained both flow-based and node-based demands.

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The resultant schedule should satisfy technical operating constraints of units such as production and ramping limits and minimum up and down time requirements, over a specific short-term time horizon. Literature survey can be categorized into mathematical, meta-heuristic and hybrid methods. The Government of India has been supporting the EV industry through schemes such as FAME1 and FAME2 with a major focus on charging infrastructure. The industry players too have been quite optimistic and shown an active interest in the overall EV Charging ecosystem.

3. EV Charging in India:

The charging infrastructure is the backbone of electric mobility but is also one of the key perceived barriers to EV adoption in India given its limited availability and long charging times. India is picking up the pace in setting up the charging infra but not as much as is there in other regions like European Union (EU), USA or China. High operating cost, Discom load and the uncertainty related to utilization rates of charging stations are holding back the charge operators from expanding their current reach.

Figure1.1 shows Architecture of EV Charging Infrastructure

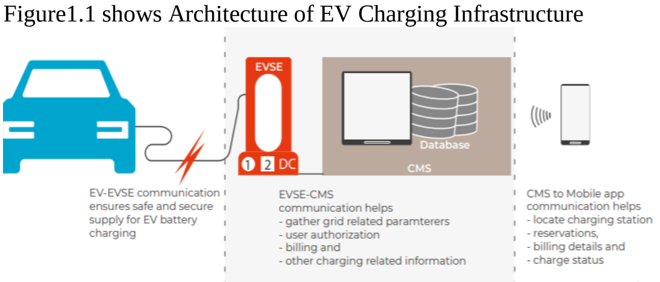

Figure 1.1: EV Charging Infrastructure

Location planning for public charging infrastructure can be conducted through a digitized geospatial analysis or as an on-ground exercise, depending on the scale of planning and the quality of geospatial data available. At an urban or regional scale, a mixed approach to location planning is recommended.

Site selection for public charging infrastructure should optimize accessibility, visibility, and ease of navigation for charging facilities. For a given charging demand in an area, a distributed planning approach may be used to select multiple charging sites, with varying configurations of the number of chargers and power levels as required. This can reduce the space and electricity load requirements at each site, and enable more efficient network implementation. Sites for public charging may include on-street parking spots, off-street public parking, transit station parking areas, or any other location with adequate space and access for all EV owners. Ownership of sites may vary and may require multiple agreements for reserved charging use.

4. Grey Wolf Algorithm

The most familiar optimization tool for solving GS problem is dynamic programming method which require more computational memory requirement as the system size increases. The renowned meta-heuristic algorithms such as GA, EP and SA, etc., requires tuning of specific algorithmic parameters. Improper selection of such parameters may lead to high convergence time and usually settle at infeasible or near-global optimal solution. In these aspects, the gwo algorithm has minimum number of algorithmic parameters, better exploration and exploitation characteristics and high local optima avoidance.

The GWO algorithm resembles the leadership hierarchy and searching mechanism of grey wolves (Mirjalili et al 2014). In the societal hierarchy, grey wolves are categorized as alpha (α), beta (β), delta (δ) and omega (ω). The α are the dominant because the group follows his/her instructions and the β ; the secondary wolves assist the α in making decisions. ω is the lowest ranking grey wolves. If a wolf is neither an α nor a β, or an ω, he/she is called δ (sub-ordinate). δ wolves come in the hierarchy next to the α and β , but they lead the ω. In addition to the social hierarchy of wolves, group hunting is another appealing societal action of grey wolves. The computational flow of GWO for solving optimization problem is detailed in the Figure 1.2.

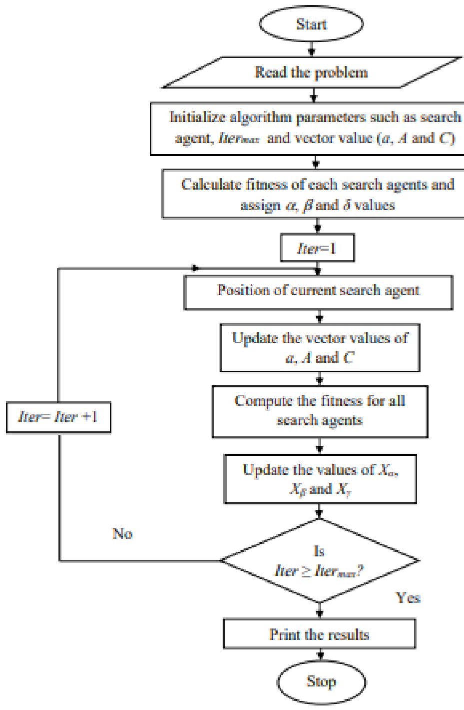

Figure 1.2: General Flowchart of GWO

The multi objective nature of the Grey Wolf Algorithm has been implemented to fixation of size and site of charging station of EV vehicles. To sum up, the relevant analytical studies along the both simulation and optimization results are analyzed and reported through MATLAB. Figure 1.3 shows the higherachy level of grey wolves.

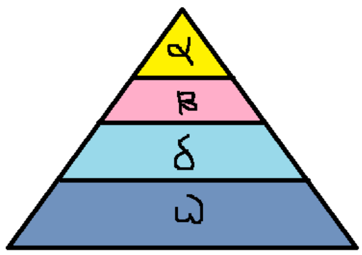

Figure 1.3: Hierarchy level of grey wolves

Step 1: Gather of system data and initialize maximum iteration value and vector variables of grey wolves.

Step 2: Grey Wolf Wolves initialization the following equation used to random selection of variables

$$\text{Wolves}=\begin{bmatrix} P_1^1 & P_2^1 & P_3^1 & \cdots & P_{Gd-1}^1 & P_{Gd}^1 \\ P_1^2 & P_2^2 & P_3^2 & \cdots & P_{Gd-1}^2 & P_{Gd}^2 \\ \vdots & \vdots & \vdots & \cdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \cdots & \vdots & \vdots \\ P_1^{Gt} & P_2^{Gt} & P_3^{Gt} & \cdots & P_{Gd-1}^{Gt} & P_{Gd}^{Gt} \end{bmatrix} \qquad \text{------ (1.1)}$$

Step 3 : Set position and Evaluate the individual fitness of variables as per the hierarchy level like first highest value α, second variable β and third variable ծ, lowest variable ῳ.

$P_\alpha = f(P)_1$, Where $f(P)_1 = f(P)_{min}$ ------(1.2)

$P_\beta = f(P)_2$, Where $f(P)_2 = f(P)_{min+1}$ ------ (1.3)

$P_ծ = f(P)_3$, Where $f(P)_3 = f(P)_{min+2}$ ----- (1.4)

Step 4: Calculate the location and sizing of EV charging station

Step 5: Update the value of vectors and compute the fitness for all search agents

Step 6: Store the variable position and set $V_P = 1$

Step 7: Initialize position and fitness value of GWO

Step 8: Calculate the fitness value with the usage of equation 1.1

Step 9: Check the variable position. Condition satistified means flow diagram moves to the final status otherwise it moves to initialization of position and fitness value

5. Convergence Characteristics of GWO

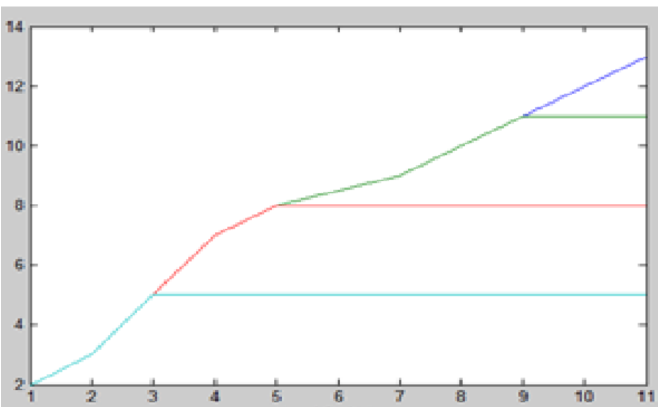

Figure 1.4 Convergence characteristics of GWO best position and sizing of MLI

The circuit model of multi level inverter is shown in figure 1.4 with MATLAB SIMULINK background.

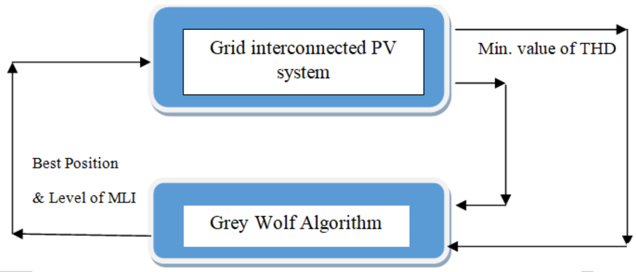

Figure 1.4: Best position and level of Grid and EV charging Station using GWO

Figure 1.5 shows the circuit model of solar with 4-MLI for EV charging Station.

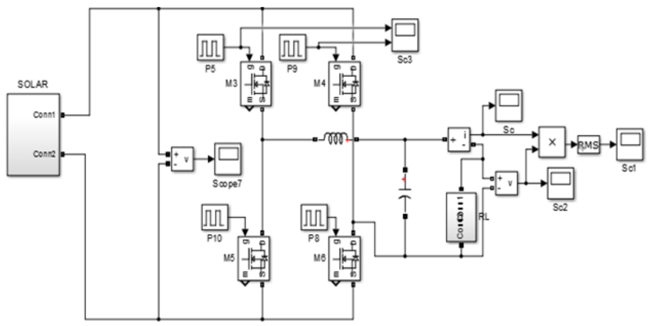

Figure 1.5: Circuit Model of solar with 4- MLI for EV charging Station

6.Conclusion:

From the above article, When planning for EV charging integration at a given site, the following planning guidelines should be kept in mind:

• Allocate space that is easily accessible and clearly visible from the site entrance.

• Select the charging location to minimize civil work and wiring requirements, where possible.

• Follow all safety provisions for EV charging planning as defined by the CEA (Measures relating to Safety and Electric Supply) (Amendment) Regulations, 2019.

• Clearly demarcate the parking spaces reserved for EV charging with appropriate signage and markings.

• Provide ample space for vehicle circulation i.e. to enter and exit the charging bays.

• Ensure that the charging area is secured against theft and vandalism.

The proposed GWO algorithm used to find the best position of EV charging station with Multi Level Inverter to connected PV panel. The analysis carried out with MLI solar panel connected with EV charging Station successfully in SIMULINK/ MATLAB background. Based on the grey wolf optimization (GWO) technique is used to fix location and level of the EV charging Station. The investigational results obtained verify the feasibility and theoretical concept of the proposed topology.

Future works can consider applying this promising algorithm to other difficult optimization problems in power systems and other areas.Among the various soft computing techniques, the GWO has superior exploration and exploitation behavior. The desirable features of GWO motivate to use as the prime optimization tool to address the intended optimization problem.

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