ONLINE MANAGEMENT OF MICROGRID

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Abstract- In India renewable energy resources having a huge potential and the installed capacity is very less as compared to the potential. India is a fast growing economy in the world and the economy is directly depending upon the power sector. Power sector plays an important role in the Indian economy. If we are looking forward to improves the Indian economy than it is necessary that power sector performs very well. By using the renewable energy resources we can also reduced the pollution content. United Nation launched a various program to reduced the carbon emission and provide the different type of subsidy to enhance the use of renewable energy resources. MNRE also provides a different type of subsidy for different type user. In this paper we discuss about the micro grid. firstly we model different micro grid combinations using different renewable energy resources. After discuss the micro grid modeling then we discuss about the online management of micro grid. In the online management we discuss varies mathematics methods like mesh adaptive direct search methods, Golden search method, multi objective optimization methods and finally we discuss game theory. By using these mathematics methods we can easily optimized the micro-grid.

Keywords-Microgrid,, Mesh Adaptive Direct Search Method, Stochastic Objective Function, Fmincon, Pattern Search Method, Optimization Model, Algorithm For MADS

1.Introduction- The Micro grid concept assumes a cluster of loads and renewable energy resources operating as a single controllable system that supply power to the local load. This concept provides a new standard for significant the operation of distributed generation. The Micro grid study construction in Figure 1.1 is shown .

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It consists of a group of various feeders, which could be part of a distribution supply system. In this architecture there is a single point of link to the utility called point of common coupling. Feeders 1 and 2 have responsive loads which should be supplied during the trial. The feeders also have the renewable energy resources consisting of a photovoltaic cell (PV), wind turbine (WT), fuel cell (FC), micro turbine (MT), diesel generator (DG), and battery for storage. The third feeder has only conventional loads. The static control switch is used to island feeders 1 and 2 from the utility when events happen. The fuel input is needed only for the Diesel generator, Fuel cell, and Micro turbine and the fuel for the Wind turbine , Micro turbine and PV cell comes from environment. To provide the load demand, electrical power can be produced either directly by PV cell, WT, DG set, MT, or FC. The diesel oil is a fuel input to a DG, whereas natural gas is a fuel input to fuel processor to produce hydrogen for the Fuel cell. The water and gas is also the input to the MT. The use of DG, or FC or MT with other fuel types can be modeled by changing the system parameters to reproduce the change in the fuel consumption characteristics.

Each component of the micro grid system is independently modeled based on its characteristics and constraints. The characteristics of some equipment like wind turbines and diesel generators are available from the proper manufacturers. Each of the local generation unit has a local controller. This is responsible for local control that corresponds to a conventional controller (ex. automatic voltage regulator (AVR) or Governor) having a network announcement function to switch over information between other local controllers and the upper central(main) controller to achieve an advanced level control. The central (main) controller also plays very important role as a local load dispatch control center in bulk power systems, which is in charge of distributed generator operations installed in micro grid.

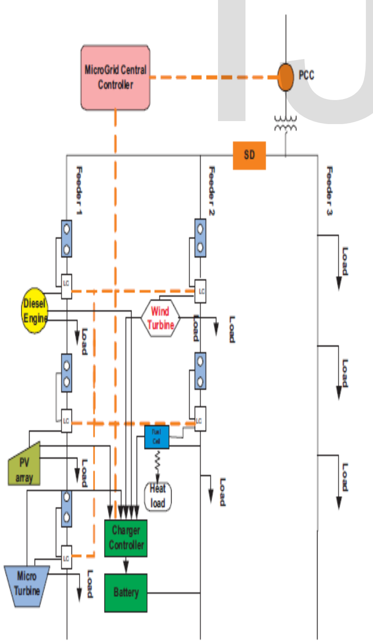

Fig 1.1

2.Management Of Micro Grid- A book management system is proposed, considering the following objectives:

Optimal use of local distributed resources;

a.Feeding of local loads;

b.Reducing the operating cost;

c.Minimizing the emission level

2.1 Applying The Mesh Adaptive Direct Search Technique To Solve The Single Objective Problem Of Micro Grid-The latest developed, efficient mesh adaptive direct search (MADS) algorithm is offered and applied. MADS algorithm is used to optimize the micro grid operating cost function. In comparison with the previously used optimization methods, a reduction in \$/Day is obtained even if the model is more complicated.

3-Microgrid Online Management Using MADS-

3.1 Introduction -Here a general formulation to resolve the optimal operating strategy and cost reducing method for a Micro Grid. The planned cost function takes into concern the cost of emission SO_2, NO_2, and CO_2, start up cost, and the function and maintaining cost. Furthermore the everyday income and outcome is joined from the purchased or sales power. The optimization is meant at reducing the cost function of the system meanwhile constraining it to meet up the demand of customer and system safety. For purpose of comparison, two different techniques are applied to solve the proposed optimization problem. The first technique is Sequential Quadratic Programming (SQP), while the second one is the Mesh Adaptive Direct Search (MADS) method. MADS is a simplification of the pattern search algorithm. These method are planned for black box optimization problem. They are derived free method that they not solve nor even try to assess derivatives. There is a wide range of interesting applications of pattern search and MADS methods. Mesh adaptive direct search method reported in is applied to the optimization management problem of a MG.

3.2 Optimization Overview

Minimize $f(P)$
$P \in R^n$

Subject To

$G_i(P) = 0, \quad i = 1, \ldots, m_e$
$G_i(P) \leq 0,$
$i = m_e + 1, \ldots m \quad P_l \leq P \leq P_u$

where P is an n dimensional vector of design parameters, $f(P)$ is the objective function, $f : Rn \rightarrow R$, and the vector function $G : Rn \rightarrow Rm$ give a vector of length m having the values of the inequality and equality constraints compute at P. Optimization techniques are used to find the design parameters vector, P = ($P1$, $P2$, ..., Pn), that can in a few way be proposed as optimal. In a simple case this be the maximization or minimization of a few system characteristic that is reliant on P. In a superior formulation the objective function, $f(P)$, to be maximized or minimized, may be topic to constraints in the shape of equality constraints, $Gi(P) = 0$ ($i = 1, \ldots, me$); inequality constraints, $Gi(P) \leq 0$ ($i = me + 1, \ldots, m$); and/or parameter bounds, Pl, Pu .

3.3 Algorithm For Direct Search Method-A general and flexible algorithmic framework for MADS was proposed in . This common framework is then focused to a specific algorithmic execution.

Initialization-The user define the starting point and the early mesh size. The algorithm initializes other parameter for successive step.

Quest for an improved mesh point

Global search (optional): evaluation of *CF* over a finite subset of point explain by The mesh; Local poll (compulsory): definition of a poll set and computation of *CF* over points in that set.

- Parameters update

Parameters are updated.

- Termination

If some stopping criterion is reached, stop; if not, go back to step 2.

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3.4 Optimization Model-The power optimization model is made and explain below. The model output is the optimal configuration of a micro grid by accounting the technical act of supply option, locally accessible energy resource, load requirement characteristic, start up costs environmental costs, every day purchased sold power tariff, and in use and maintening costs.

Figure 3.1 illustrate the optimization model where their inputs are:

- The demand of power by the load.
- locally available energy resources data: These have solar irradiation data (W/m2), temperature (◦C), wind speed (m/s), as well as fuel cost($/liter) for the DG and natural gas cost for the supply of the FC and MT ($/kW).
- Sold power and sold Daily purchased in ($/*kWh*).
- Start up cost in ($/*h*).
- Economic and Technical performance of supply option: These characteristics comprise for example rated power of photovoltaic, power curve for WT, DG fuel consumption characteristics, FC and MT.
- Maintenance and Operating cost and emission factor: Maintenance and Operating cost be given as ($/h) for all emission; factors of emission be given in kg/h for FC, DG, and MT.

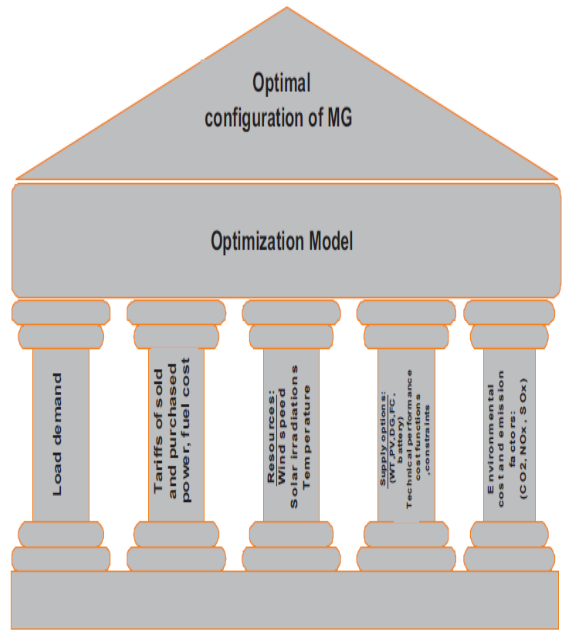

Fig 3.1

3.5 Proposed Objective Functions

In the design a major concern of an electrical system that utilize MG source is the accurate selection of power at output. The power economically satisfies the load demand, while taking the environmental externality cost byreducing the emission of oxides of sulfur oxides (SO2), nitrogen (NOx), and carbon oxides (CO2). In this section, different scenarios of the MG operation are considered. These scenarios are:

Scenario 1: The MG is considered to be working in an islanding condition with no battery storage in the MG, with power balance and power generation constraints.

Scenario 2: Again the islanding condition is considered, with a battery storage. Furthermore, more constraints are added to reflect some of the behavior which can be found in the MG.

Scenario 3: The MG is considered to be connected to the upper grid, taking into account the battery storage and the constraints in the pervious two Scenarios. The following subsections describe how these Scenarios are implemented in detail. In power balance constraints, the line loss is not considered here as it is quite small and could be neglected.

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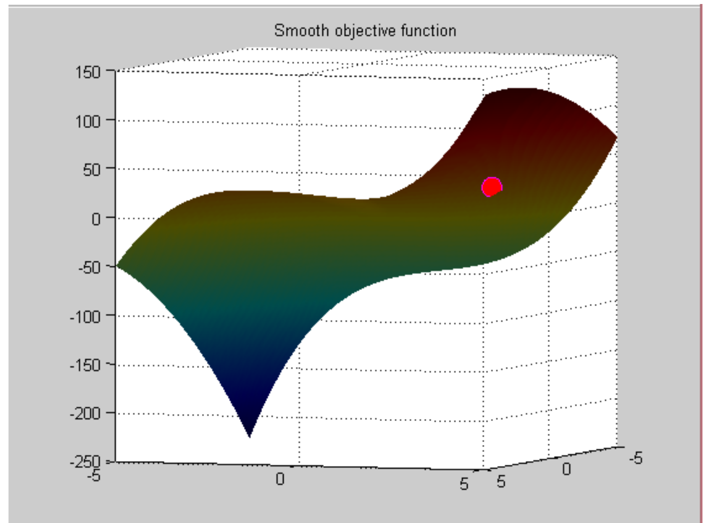

output of inialization of search method

3.6 Search Method Inialization

```
%inialization
X0 = [2.5 -2.5];   % Starting point.
LB = [-5 -5];      % Lower bound
UB = [5 5];        % Upper bound
range = [LB(1) UB(1); LB(2) UB(2)];
Objfcn = @smoothFcn; % Handle to the objective function.
% Plot the smooth objective function
clf;showSmoothFcn(Objfcn,range); hold on;
title('Smooth objective function')
plot3(X0(1),X0(2),Objfcn(X0)+30,'om','MarkerSize',12, ...
   'MarkerFaceColor','r'); hold off;
set(gca,'CameraPosition',[-31.0391  -85.2792 -281.4265]);
set(gca,'CameraTarget',[0 0 -50])
set(gca,'CameraViewAngle',6.7937)
fig = gcf;
```

3.6.1 Objective Function

RUN FMINCON ON A SMOOTH OBJECTIVE FUNCTION

The objective function is smooth (twice continuously differentiable). We will solve the optimization problem using FMINCON function from the Optimization Toolbox. FMINCON finds a constrained minimum of a function of several variables. This function has a unique minimum at the point x=(-5.0,-5) where it has a function value f(x*) = -250.

```
% Set options to display iterative results.
options = optimset('Algorithm','active-set','Display','iter', ...
   'OutputFcn',@fminuncOutps);
[Xop,Fop] = fmincon(Objfcn,X0,[],[],[],[],LB,UB,[],options)
```

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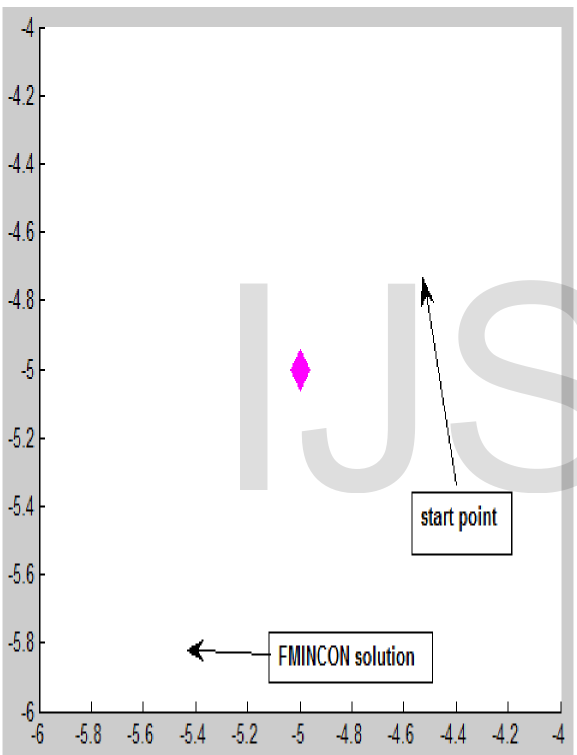
figure(fig);

hold on;

% Plot the final point

plot3(Xop(1),Xop(2),Fop,'dm','MarkerSize',12,'MarkerFaceColor','m');

hold off;



output of objective function

3.6.2 Stochastic Objective Function

%Stochastic Objective Function

%The objective function we used here is exactly same as the pre defined example but

%with some type of random occur noise added to it. This is done by adding a random component to the function value.

% Reset the state of random number generator

reset(RandStream.getDefaultStream);

peaknoise = 4.5;

Objfcn = @(x) smoothFcn(x,peaknoise); % Handle to the objective function.

% Plot the objective function (non-smooth)

fig = figure;

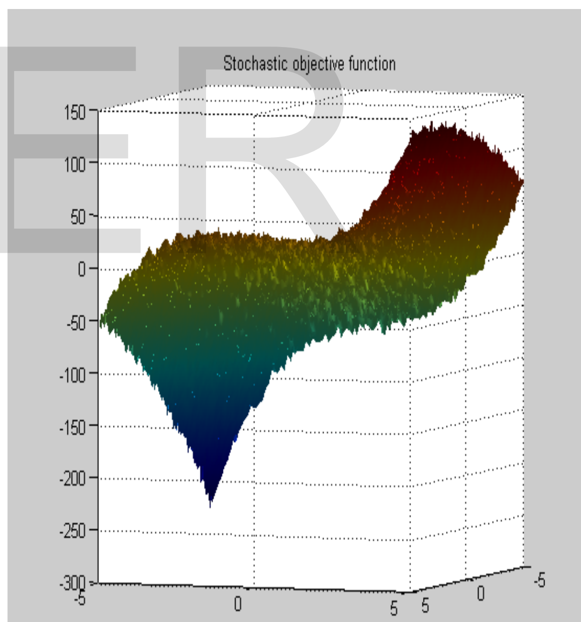
showSmoothFcn(Objfcn,range);

title('Stochastic objective function')

set(gca,'CameraPosition',[-31.0391 -85.2792 -281.4265]);

set(gca,'CameraTarget',[0 0 -50])

set(gca,'CameraViewAngle',6.7937)



output result of stochastic objective function

3.6.3 Fmincon On A Stochastic Objective Function

% RUN FMINCON ON A STOCHASTIC OBJECTIVE FUNCTIO

%The objective function is stochastic and not smooth. FMINCON is a general

%constrained optimization solver which finds a local minima using first

%derivative of the objective function. If derivative of the objective

%function is not provided, FMINCON uses finite difference to approximate

%first derivative of the objective function. In this example, the

%objective function have some random noise in it. The derivatives hence

%could be highly unreliable. FMINCON can potentially stop at a point which

%is not a minimum. This may happen because the optimal conditions seems to

% be satisfied at the final point because of noise or it could not make any

% progress.

%options = optimset('Algorithm','active-set','Display','iter');

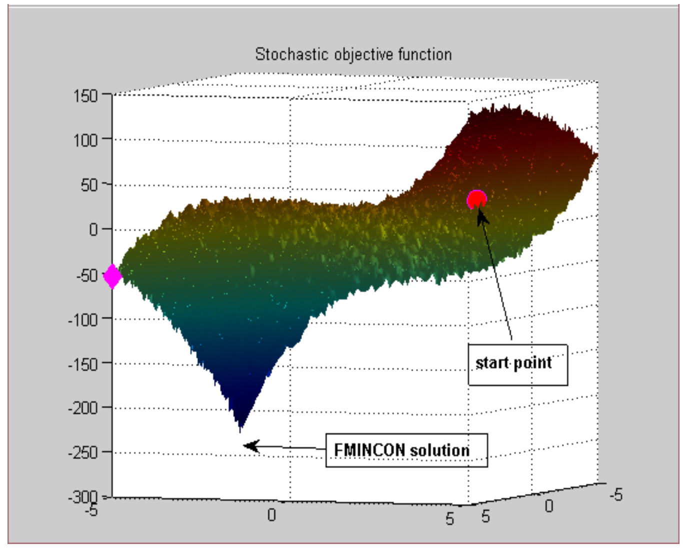
[Xop,Fop] = fmincon(Objfcn,X0,[],[],[],[],LB,UB,[],options)

figure(fig);

hold on;

plot3(X0(1),X0(2),Objfcn(X0)+30,'om','MarkerSize',12,'MarkerFaceColor','r');

plot3(Xop(1),Xop(2),Fop,'dm','MarkerSize',12,'MarkerFaceColor','m');



fmincon solution

3.6.4 Pattern Search Method

%RUN PATTERNSEARCH

% We will now use PATTERNSEARCH from the Global Optimization Toolbox.

% Pattern search optimization techniques are a class of direct search methods

%for optimization. A pattern search algorithm does not require any derivative

%information of the objective function to find an optimal point.

PSoptions = psoptimset('Display','iter','OutputFcn',@psOut);

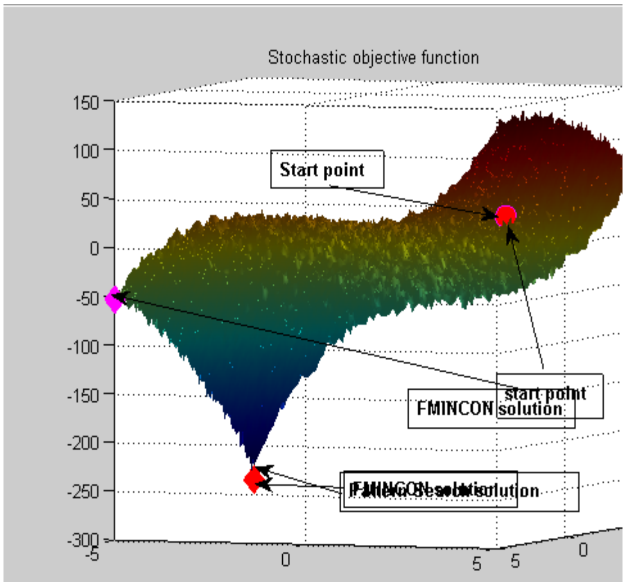
[Xps,Fps] = patternsearch(Objfcn,X0,[],[],[],[],LB,UB,PSoptions)

figure(fig);

hold on;

plot3(Xps(1),Xps(2),Fps,'dr','MarkerSize',12,'MarkerFaceColor','r');

hold off



pattern search output results

3.7 Conclusion

The optimization problem includes a variety of energy sources that are likely to be foundin a MG: a fuel cell, a diesel generator, a microturbine, a photovoltaic cell, and a wind generators.Constraint functions are added to the optimization problem to reflect some of the additional considerations which are often found in a small-scale generation system. From the results obtained, it is clear that the optimization works very well and assigns optimal power to the generators after taking into account the cost function for each of them. The effectiveness of the suggested approach is confirmed through the agreement between the optimized settings and the output from the algorithm. The responses are effected by several variables including weather conditions, emissions operation and maintenance costs, sold and purchased tariffs, and of course, the actual power demand. The results show the capability of the proposed system model and the proposed algorithm to achieve both reduction in the operating costs and meeting the load demand.

The proposed procedure can be implemented with different loads and for periods more than one day. From the results obtained it is noticeable that the effect of changing the sold tariffs results in different optimal settings of the MG depending on the optimization technique. It is clear that the sold tariffs have more effect on the SQP method, and a smaller effect on the MADS method. Both optimization techniques made a good selectionto meet the load demand. Furthermore, some constraints were found not to be activewhen MADS method is applied. The total cost per day was the lowest when the MADS is used in all cases

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