APPLICATION OF OPTIMIZATION TECHNIQUES IN SMART GRIDS

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Abstract— **Nowadays modern power system networks have to face a number of challenges increasing like electricity demand, emission of green house gases, reduction of losses, costs of electrical generation and voltage deviation. From the perspective of global warming mitigation and depletion of energy resources, renewable energy such as wind generation and photovoltaic generation are getting attention in distribution systems. Additionally all-electric apartment houses or residence such as dc smart houses are increasing. However due to the fluctuating power from renewable energy sources and loads, supply demand balancing power system becomes problematic .Smart grid is a solution to this problem. This project presents a methodology for optimal operation of smart grid to minimize the power flow fluctuations. In this project various optimization techniques are applied to minimize power flow fluctuations in smart grid.**

Index Terms— smart house, smart grid, interconnection point power flow, battery, neural network, optimal operation.

I. INTRODUCTION

Due to global warming and exhaustion of fossil fuels, we are required to reduce co_2 emissions and energy consumption. However co_2 emissions and energy consumption are increasing rapidly due to the proliferation of all-electric houses. As counter -measures against these problems, in residential sector, installation of photovoltaic system are proposed. On the other hand, many of the dispersed generators such as PV can be connected to Direct current sources and DC systems are expected to be of high efficiencies and rectifier circuits. It is possible to operate PV and SC systems in residential house with high efficiency. Therefore, equipments can help to reduce the use of fossil fuel and the emission of co_2. As these research, suppress of power fluctuation by renewable energy are proposed [1]. However, installation of renewable energy causes frequency fluctuation and distribution voltage fluctuation because output power from renewable source fluctuates due to weather condition. In addition, electricity cost is determined by maximum electric power consumption for the year. Hence it is possible to reduce electricity cost by achieving load following control using power storage facility. It is necessary to smooth power flow from distribution system to achieve above technical problems and reduce electricity cost. Because of the above factors, smart grid concept is developed which cooperatively balances supply-demand between power supply side and power demand side. By applying the smart grid concept, we can expect high efficiency power supply, energy conservation and low-carbon society [5]. For the research of smart grid, a method to obtain the optimal operation of thermal unit, battery and controllable loads by deciding the thermal unit commitment .The thermal units can operate in high efficiency by operating the controllable loads in coordinated manner and can achieve to reduce the total cost of thermal units. However, mainly focus on both supply and demand side for maintaining supply-demand balance controllable loads can be used. The study of supply-demand balancing by power consumption control of controllable load at each demand side in small power system. This project presents an optimal operation method of DC controllable loads in the residential houses as a smart grid. The DC smart house consists of a solar collector (sc), a PV generator, a heat pump (HP), and a battery. HP and a battery are used as controllable loads in this project.

The proposed method has been developed in order to achieve the interconnection point power flow within the acceptable range and the reduction of max-min interconnection point power flow error as low as possible to smooth the supply power from distribution system. Power consumption of controllable load is determined to optimize the max-min interconnection point power flow error based on the information collected from power system through communication system. By applying the proposed method, we can reduce the interconnection point power flow fluctuation, and it is possible to reduce electricity cost due to the reduction of the contract fee for the electric power company. Also, by using battery as the power storage facility, which can operate rapidly for charge and/or discharge, the rapid output fluctuations of DC load and PV generator are compensated. Ultimately, it is important to assume an independently operation from power system such as isolated island. Effectiveness of the proposed control system is validated by results using MATLAB.

II. SMART GRID

The genesis of early power systems and electric power grids during the past 130 years was enabled by automation and control

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of electromechanical machinery and power delivery networks. Today's end-to-end power and energy systems (from fuel source to end use) fundamentally depend on embedded and often an overlaid system of sensors, computation, communication, control and optimization. There are even more opportunities and challenges in today's devices and systems, as well as in the Emerging modern power systems – ranging from dollars, watts, emissions, standards, and more – at nearly every scale of sensing and control. Recent policies combined with potential for technological innovations and business opportunities, have attracted a high level of interest in smart grids. The potential for a highly distributed system with a high penetration of intermittent sources poses opportunities and challenges. Any complex dynamic infrastructure network typically has many layers, decision-making units and is vulnerable to various types of disturbances. Effective, intelligent, distributed control is required that would enable parts of the networks to remain operational and even automatically reconfigure in the event of local failures or threats of failure. This presentation provides an overview of smart grids and recent advances in distributed sensing, modeling, and control, particularly at both the high-voltage power grid and at consumer level [3]. Such advances may contribute toward the development of an effective, intelligent, distributed control of power system networks with a focus. The smart grid is a combination of hardware management and reporting software built take an intelligent communication infrastructure. In the world of the smart grid consumers and utility companies alike have tools to manage monitor and respond to energy issues. Smart grids provide an excellent opportunity to manage power quality better and reduce harmonic distortions of the power networks.

A. Advantages

The dc grid has the following advantages compared to an ac grid [6].

1) Each power generator connected to the dc grid can easily be cooperated because it controls only the dc bus voltage.

2) When the ac grid experiences abnormal or fault conditions, the dc grid is disconnected from the ac grid, and then it is switched to stand-alone operation in which the generated power is supplied to the loads connected to the dc grid.

3) The cost and loss of dc system can be reduced because only a single ac-grid-connected inverter unit is needed.

4) Distributed generators usually supply dc power. Therefore, the phase detection like ac grid is not needed. Therefore, the cost and loss of the system can be reduced.

5) Although the dc distribution line is required, the cost performance of dc houses, hospitals and information centers are satisfactory.

III. Block Diagram

Fig1 shows the smart grid diagram, it consist of six houses and control system. Six houses and control system are connected to the smart grid.Pit is interconnection point power from power system to Smart grid.

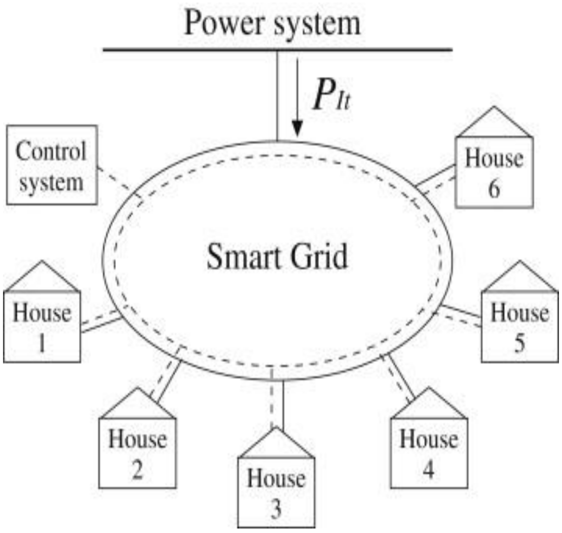

Fig 1 Smart grid block diagram.

A.DC smart house model

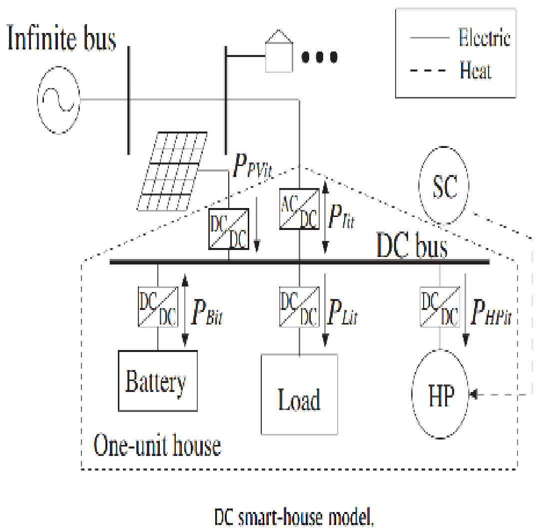

Fig 2 Smart house model.

Fig 2 shows the smart house model,Power from the Eb and PV are fed to the DC bus. From the DC bus power is transfer to Smart house.Smart house consist of Battery and loads.

B. Optimization method

Function minimizes interconnection point power flow

Objective function

Min F=∑(Blcen-Pit)2, (1)

PLt=Pit+PBt+Ppvt-Phpt, (2)

Pit=PLt-PBt-Ppvt+Phpt, (3)

Pit=PL-PBt-Ppvt,where PL=Phpt+PLt.

Blcen=Interconnection point power flow reference.

Pit=Interconnection point power flow from power system to smart grid.

PL=Power consumption in controllable load.

PBt=Battery output power.

Ppvt=pv output power.

Phpt=Power consumption in Heat pump.

Constrains

Pimin<Pi<Pimax.

|Pb|<Pbmax.

Assume,(12 hours)

Blcen=5000,PL=3000w,Pv=8000W.

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1000<=Pb<=36000,1000<Pi<5000.

C.Calculation

Power consumption in one day for Smart house
total number of hours per day=12hrs.
assume power consumption of load =3000w.
solar panel rating =100w.
number of panel=80.

1.Table for power in oneday:

Time duration	Average power (wh)	Total power(kwh)
6am-9am	50(3hrs)	24
9am-3pm	100(6rs)	48
3pm-6pm	50(3hrs)	24

Saving of power in battery (6am-9am&3pm-6pm)=24-18=6kwh.
Saving of power in a battery(9am-3pm) =30kwh.
Battery rating=12v,100w.
Number of battery=30.

IV. NEURAL NETWORK

The science of artificial neural networks is based on the neuron. In order to understand the structure of artificial networks, the basic elements of the neuron should be understood.Neurons are the fundamental elements in the central nervous system. A NN is a machine learning approach inspired by the way in which the brain performs a particular learning task Knowledge about the learning task is given in the form of examples Inter neuron connection strengths (weights) are used to store the acquired information (the training examples). During the learning process the weights are modified in order to model the particular learning task correctly on the training.Neural networks have shown great progress in identification of nonlinear systems. There are certain characteristics in ANN which assist them in identifying complex nonlinear systems[14].

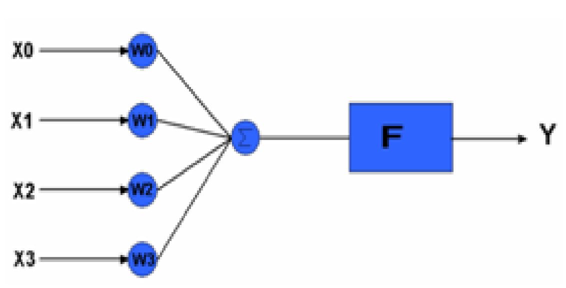

Fig 3 Neural Network

ANN are made up of many nonlinear elements and this gives them an advantage over linear techniques in modelling nonlinear systems. ANN are trained by adaptive learning, the network 'learns' how to do tasks, perform functions based on the data given for training. The knowledge learned during training is stored in the synaptic weights. The standard ANN structures (feedforward and Back propagation) are both used to model.

A.Advantages

1. The main advantage of neural networks is that it is possible to train a neural network to perform a particular function by adjusting the values of connections (weights) between elements. For example, if we wanted to train a neuron model to approximate a specific function, the weights that multiply each input signal will be updated until the output from the neuron is similar to the function.
2. Neural networks are composed of elements operating in parallel. Parallel processing allows increased speed of calculation compared to slower sequential processing.
3. Artificial neural networks (ANN)have memory. The memory in neural networks corresponds to the weights in the neurons. Neural networks can be trained offline and then transferred into a process where adaptive learning takes place. In our case, a neural network controller could be trainedto control an inverted pendulum system offline say in the simulink environment. After training, the network weights are set. The ANN is placed in a feedback loop with the actual process. The network will adapt the weights to improve performance as it cont rols the pendulum system.

The main disadvantage of ANN is they operate as black boxes. The rules of operation in neural networks are completely unknown. It is not possible to convert the neural structure into known model structures such as ARMAX, etc. Another disadvantage is the amount of time taken to train networks. It can take considerable time to train an ANN for certain functions.

B. Simulink Model

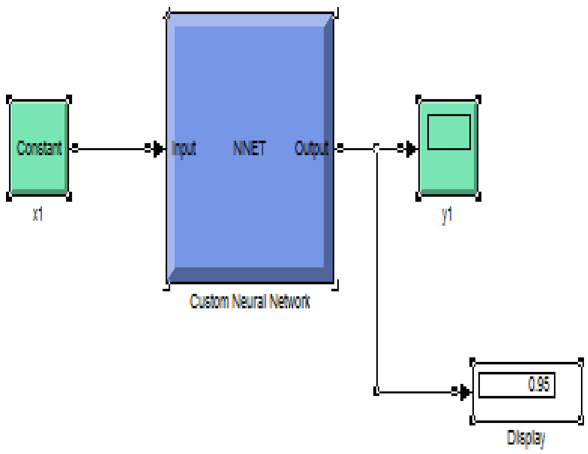

Fig 4 Simulink model.

Fig 4 shows the Neural Network model. This Network is trained by hundred inputs and hundred targets. The constant x1 is varied the output is also varied. It maintains the constant value. PV is representing inputs, EB is representing target.

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C.SimulationDiagram

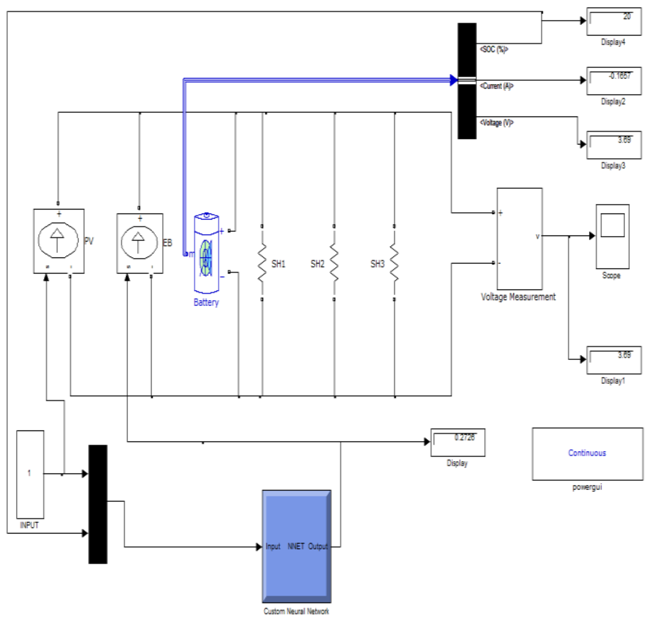

Fig 5 Simulation diagram

Fig 5 shows the simulation diagram, Simulation diagram operations are given below,

Neural network tool box is trained by hundred inputs and targets. Photovoltaic cell, EB power is obtained by variable current source blocks. The resistive loads are considered as SMART HOUSES. Run the simulation model for normalised value 1 is constant input, the output is no change. Then decrease the input value the output is changed, the EB output is changed. Compensate the variable EB output by using PV. PV is not satisfied to meet the demand. Battery is also satisfying the load demand. Output, current and storage capacity are displayed by display units.

Battery and PV systems are providing minimize the power flow fluctuations from the EB. Neural Network tool box is providing optimum operation of simulation. It is more time consuming over than other optimization techniques.

D. Training Network

Fig 6 shows the Neural Network training model, it reaches the 6 iteration and time duration is 2ms. neural network tool box trained by hundred inputs and hundred targets using fitting tool . The training neural network tool box maintains the constant output value. The performance curve is shown the best validation for negative value. The performance curve shows the optimal operation for the best validation for all iteration.

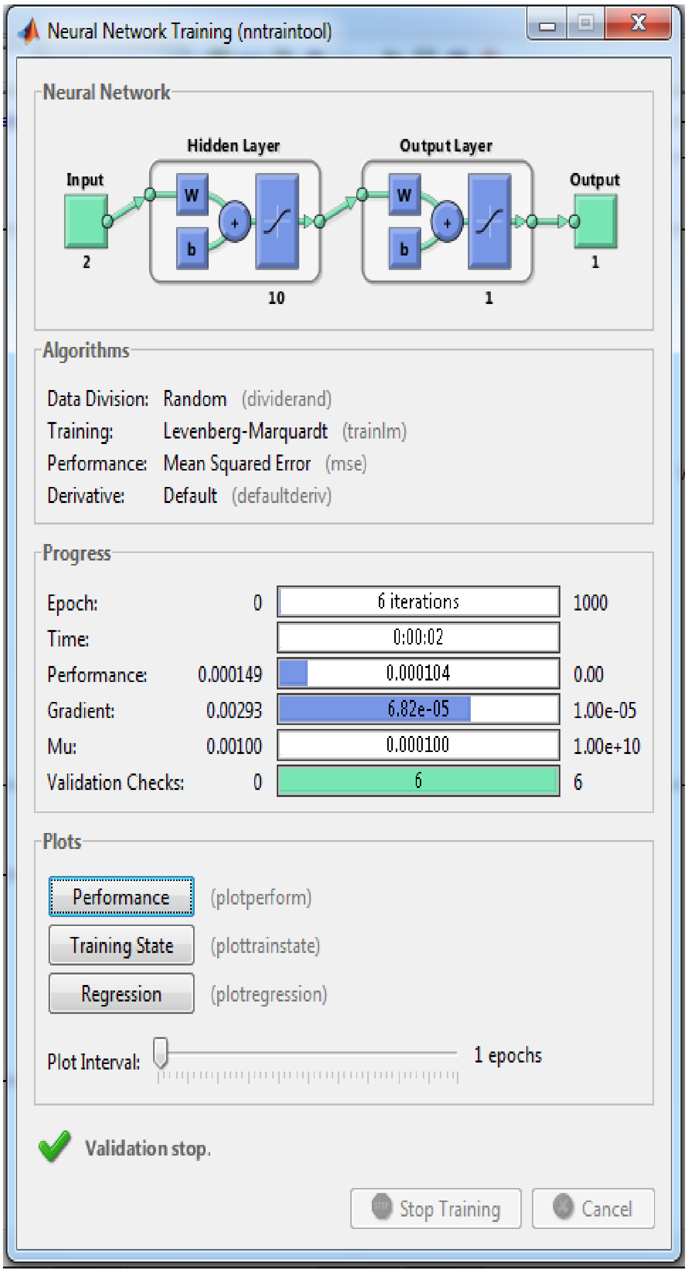

Fig 6 Training model.

E. Performance Curve

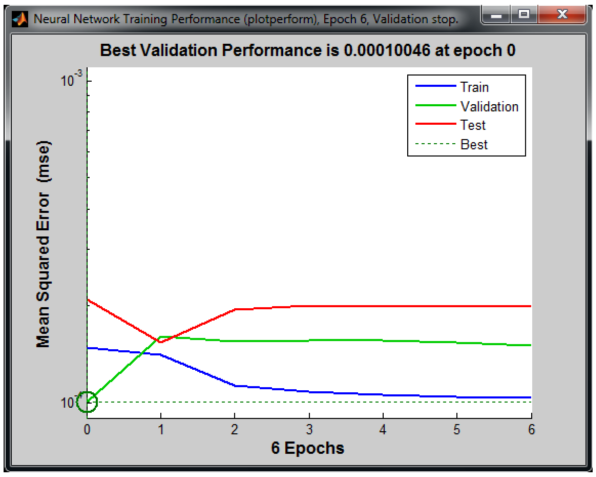

Fig 7 Performance curve.

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Fig 7 shows the performance curve, it shows the best validation for each iteration. The curve shows mean square error value is less. It reduces the power flow fluctuations.

F. Result and discussion

Base paper result based on the tabu search algorithm. This project result tabu search algorithm replaced by neural network. In this method shows the result in three unit house. Finally reduce the interconnection point power flow fluctuation achieved by photovoltaic system using normalised neural network simulation model.

V. CONCLUSION

This project has determined an optimal operation for DC smart house group, in smart grid, which consists of a battery and a HP as controllable loads that may steadily increase in the demand side in the future. As an optimization method, we have used the neural network which determines the operation method of controllable loads, to suppress interconnection point power flow fluctuation, based on information obtained by the communications infrastructures. By smoothing interconnection point power flow, it is possible to reduce electricity cost due to the reduction of the contract fee of the electric power company. Power consumption in smart grid is smoothed by achieving the neural network, so we can suppress the impact of PV against power system. Consequently, we can expect high quality power supply and reduce the cost by cooperative control in smart grid.

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