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RESEARCH ARTICLE

POWER MANAGEMENT STRATEGY BASED ON ADAPTIVE NEURO FUZZY INFERENCE SYSTEM FOR AC MICROGRID

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Abstract

Micro grids increase the efficiency and resiliency of electrical networks. However, the uncertain nature of renewable energy resources integrated into the MGs usually results in different problems. We are trying to achieve a stable system which can power microgrids and can be of commercial use. This would be achieved by simulation of the system under different climatic conditions.

Keywords: Microgrid Optimization, ANFIS, Neural Network, Fuzzy Logic

Introduction

A microgrid is a self-sufficient energy system that serves a limited geographical area such as a hospital, a neighbourhood etc. A micro grid consists of one or more distributed energy to produce its power like

- Wind turbines
- Solar panels
- Heat and power generators
- Some also contains energy storage typically from batteries.

Since residential load requires a constant power supply, which is aimed to be achieved by the use of microgrid, Wind Turbine (WT) and solar panels (SP) produce a very unstable energy supply, which needs to be compensated by a diesel generator (DG) (a non-renewable energy source). We need to tune WT & SP in synchronization with DG so that minimum use of DG is there. This calls for a need of an effective controller which can communicate with the three sources and provide a stable power supply, by taking the parameters like temperature, wind speed, solar irradiation into consideration and propose a mechanical load requirement for DG.

A combination of an effective NEURAL NETWORK and FUZZY LOGIC can be used to construct a controller which can be helpful for our purpose. ANFIS (Advanced Neuro Fuzzy Inference System) is the controller we are going to use for the same.

Literature survey

(Zia, *et al*., 2018) Renewable energy resources are currently being deployed on a large scale to meet the requirements of increased energy demand. This review paper helps in analyzing decision making strategies for microgrid energy management system.

(Vera et al., 2019) Renewable energy sources have emerged has helped to meet the growing demand of energy. This paper presents a literature review of energy management in microgrid systems using renewable energies, along with a comparative analysis of the different optimization objectives, constraints, solution approaches, and simulation tools applied to both the interconnected and isolated microgrids. Idea of energy storage technologies has been introduced to cope with the uncertain nature of microgrids.

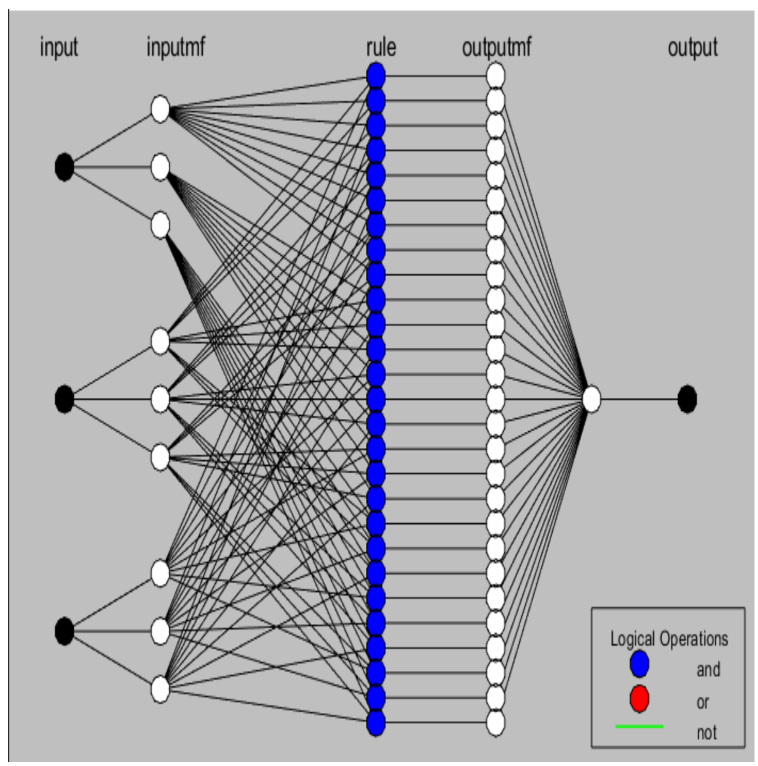
(Bhaduri *et al*., 2020) Power management in Microgrid (MG) is a major issue while utilizing generation elements like photovoltaic, wind turbine, distributed generator, and battery bank with loads and non-linear loads. In this paper, power management is achieved through the deployment of the supervisory controller with hybrid power management algorithm named Artificial Neuro-Fuzzy Interference System (ANFIS) with Elephant Herd Optimization (EHO) algorithm. The aim was to keep a stable power flow among all renewable energy sources and the load and ensuring that the battery power does not exceed thelimits. The simulation and the experimental results are investigated with some existing methods to analyze the efficiency of the proposed method.

Methodology

For this project, a random sample dataset has been fed to ANFIS controller.

ANFIS

In the network structure, there are two sections that may be identified: the premise and the consequence parts. The architecture is made up of five layers in total. The input values are passed through the first layer, which determines the membership functions that apply to them. It's also known as the fuzzification layer. The premise parameter set, namely a,b,c, is used to calculate the membership degrees of each function.

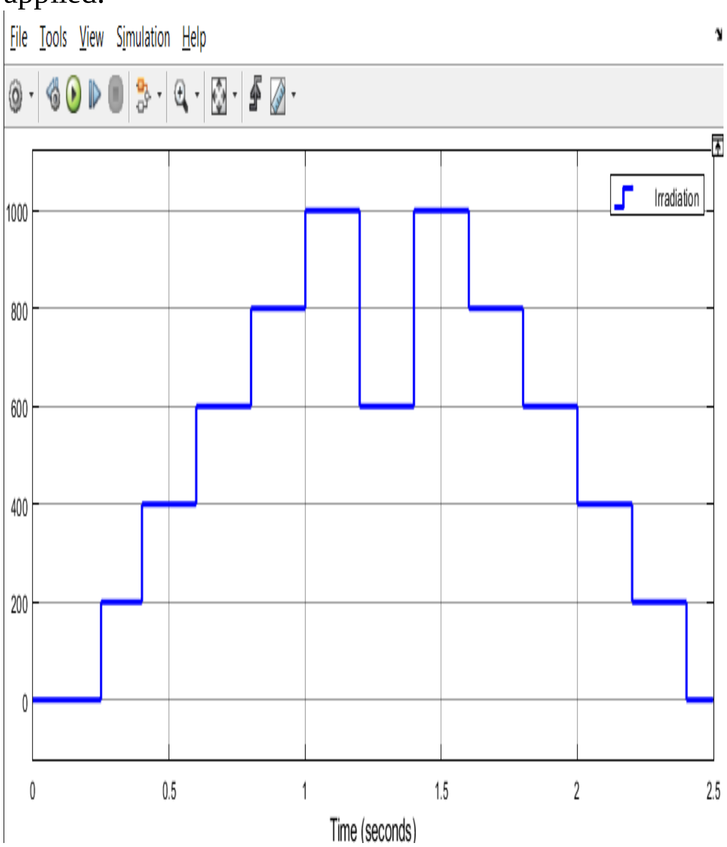


The firing strengths for the rules are generated by the second layer. The second layer is referred to as the "rule layer" because of its function.

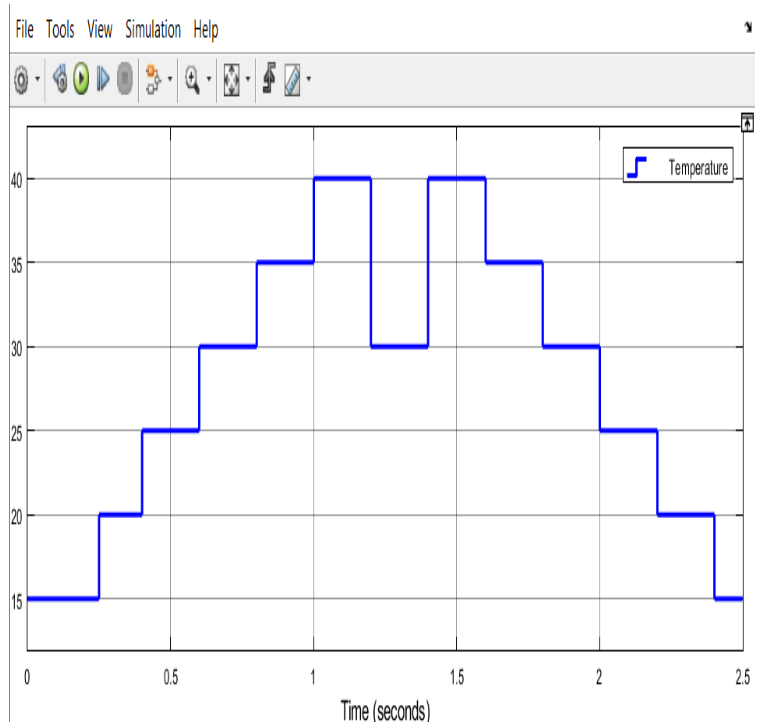
The third layer's job is to divide each value by the total firing strength to normalise the computed firing strengths. The normalised data and the result parameter set p, q, r are fed into the fourth layer. This layer returns the defuzzified values, which are then transferred to the final layer, which returns the final output.

Result

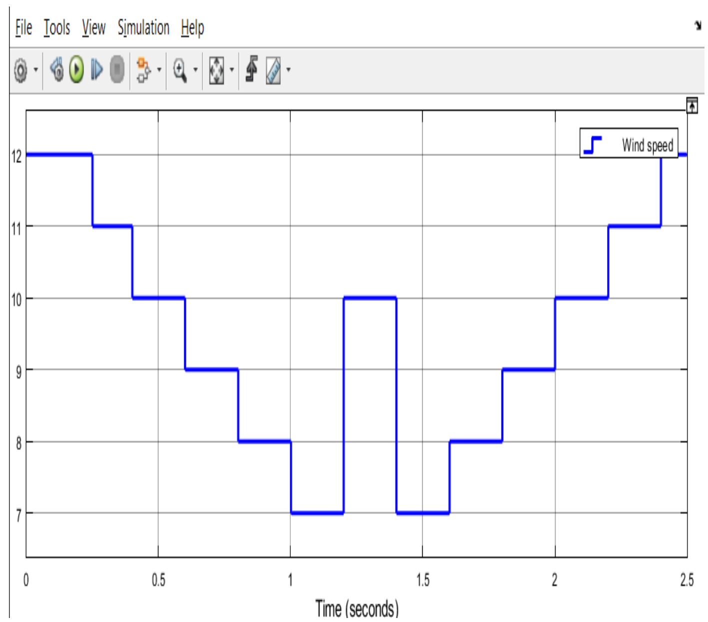
Input to the system in the form of temperature, wind speed, solar irradiation has been applied.



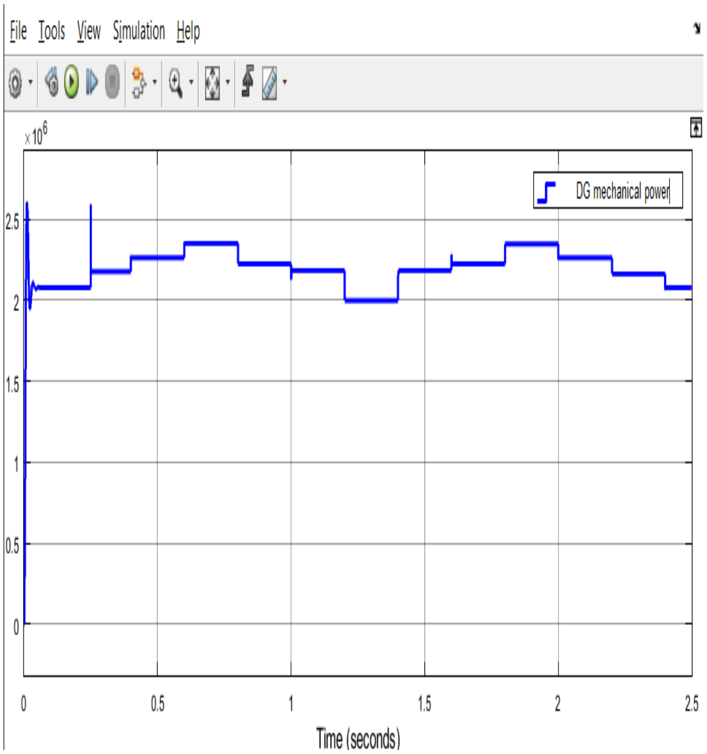
Solar irradiation (w/m^2) vs Time (seconds)



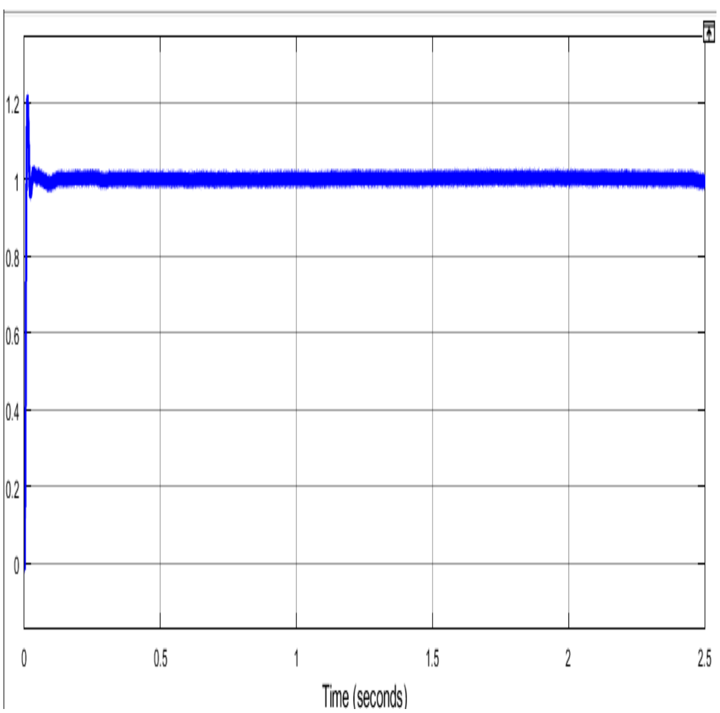
Ambient Temprature(Celsius) vs Time (Seconds)



Wind speed (m/s) vs Time (seconds)



Diesel generator power (w) vs Time (Seconds)



Microgrid voltage (pu) vs Time (Seconds)

Result

Voltage across microgrid is constant, with inconsistencies under acceptable range.

Conclusion

Initial set of input and output data are fed to the ANFIS controller and their working is simulated on a graph which mimics different climatic conditions, and voltage stability across microgrid is achieved.

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