

Implementing a Fuzzy Logic Based Algorithm to Predict Solar and Wind Energies in a Hybrid Renewable Energy System

Sanaa Faquir, Sidi Mohamed Ben Abdellah University, Fes, Morocco

Ali Yahyaouy, Sidi Mohamed Ben Abdellah University, Fes, Morocco

Hamid Tairi, Sidi Mohamed Ben Abdellah University, Fes, Morocco

Jalal Sabor, ENSAM-MEKNES, Meknes, Morocco

ABSTRACT

The use of multi sources systems of energy progressed significantly in different industrial sectors. Between all the existing sources of energy, batteries and renewable sources, such as photovoltaic and wind, contain the highest specified energy. However, solar and wind energies are not available all the time, their performance is affected by unpredictable weather changes and therefore, it is difficult to control as it is not always feasible to obtain an accurate mathematical model of the controlled system. Also, uncertainty of the wind power can affect system stability. This paper presents a computer algorithm based on fuzzy logic control (FLC) to estimate the wind and solar energies in a hybrid renewable energy system from natural factors. The wind power was estimated using the wind speed as an input parameter and the solar power was estimated using the temperature and the lighting as input parameters.

Keywords: Computer Algorithm, Fuzzy Logic, Fuzzy Modeling, Hybrid Renewable Energy System, PV Panels, PV Power, Wind Power, Wind Turbine

INTRODUCTION

The rapid increase of the population and the consumption of energy in the world as well as the depletion of fossil resources generated a significant rise in the prices of natural resources such as petrol and natural gas. This elevation led to the use of hybrid renewable energy systems (HRES).

In contrast to fossil energy, renewable energy comes from resources which are continually refilled such as sunlight, wind, rain, tides, waves and geothermal heat, and it must be harvested when it is available. Among all the renewable sources of energy, photovoltaic (PV) and wind energies are being widely utilized.

HRESs composed of PV panels, a wind turbine (WT), and one or two energy storage

DOI: 10.4018/IJFSA.2015070102

systems (ESS) have a long lifetime and normally low maintenance cost. They also offer many advantages over other generation systems: Low pollution, high efficiency, reusability of exhaust heat, and on-site installation (Atia, Fahmy, Ahmed, & Dorrah, 2012). For these reasons, Advances in WT and PV energy technologies have increased their use in these systems (Mermoud, 2010; El-Shater, Eskander, & El-Hagry 2006). Over the past three decades, several models have been developed in order to generate the solar irradiance data based on stochastic models such as autoregressive (AR), autoregressive moving average (ARMA), autoregressive integrated moving average (ARIMA) and Markov chain (Aguiar & Collares-Pereira, 1992; Mora-Lopez & de Cardona, 1998; Santos, Pinazo, & Canada, 2003; Maafi & Adane, 1989). However, these models, based on the probability estimation, do not always give accurate results as they require the precise definition of problem domains as well as the identification of mathematical functions. This is why most stochastic models were found with relatively big errors and sometimes difficult to be adopted widely. On the other hand, energy output estimation for wind turbines of different power ranges has been the subject of a number of papers (see Jafarian & Ranjbar, 2010). The wind speed pattern of a region was used to predict the energy output of the turbine in most of these studies. However, under many conditions, crisp data are insufficient to represent mathematically real-life decision problems. Indeed, human judgments including preference information are vague or fuzzy in nature and may not be appropriate to represent them by accurate numerical values. Fuzzy sets, linguistic variables and intuitionistic fuzzy (IF) sets are better solutions to model these problems (Shu-Ping & Deng-Feng, 2013). In the same vein, complications inherent in systems that combine cooling, heating, and power make it difficult to attain exact numerical data for quantitative criteria. Fuzzy theory can, therefore, play an essential role in the decision-making process whereby fuzzy evaluation can quantitatively represent the qualitative evaluation from decision makers (Jing, Bai, & Wang, 2012).

This paper presents a study of a hybrid renewable energy system (HRES) combining 16 PV panels and one generic WT and proposes an algorithm based on fuzzy logic and natural parameters to predict the wind and solar powers under any weather conditions without dealing with complex mathematical formulas. The system can provide a maximum of 4.5KW of energy per day. Linguistic control rules derived from expert knowledge were written based on three natural input parameters: The wind speed, the temperature and the solar lighting.

The fuzzy control language was incorporated into the algorithm to implement the fuzzy logic control (FLC) phases. A further method of energy management will be required in future work to control the flow of energy in the HRES between the input sources and the batteries.

HYBRID RENEWABLE ENERGY SYSTEMS (HRES)

Renewable energies are inexhaustible and site-dependent sources of energy that can be used in a self-directed manner (used in the same place where they are produced). They don't require transformers or underground pipes, or distribution networks. They are resistant to the most unfavorable weather conditions, such as rain, snow and wind. They have no environmental impact. Furthermore, they don't contaminate nature or break down the landscape with towers, stations and electric lines. For these reasons, research and development efforts in solar, wind, and other renewable energy technologies are ongoing continue to improve performance and establish innovative techniques for accurately predicting power output and reliably integrating those energies with other conventional generating sources (P. Nema, N. Nema, & Rangnerak, 2009).

Solar and wind energies have the advantage of complementing each other (Courtecuisse, Sprooten, & Robyns, 2013): Solar radiation provides the energy during cleared days (usually days with little wind), while during cloudy and windy days; it is the wind that provides sufficient energy to operate the turbine. Also,

13 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the product's webpage:

www.igi-global.com/article/implementing-a-fuzzy-logic-based-algorithm-to-predict-solar-and-wind-energies-in-a-hybrid-renewable-energy-system/127309?camid=4v1

This title is available in InfoSci-Journals, InfoSci-Journal Disciplines Computer Science, Security, and Information Technology. Recommend this product to your librarian:

www.igi-global.com/e-resources/library-recommendation/?id=2

Related Content

Fuzzy Dynamic Load Balancing in Virtualized Data Centers of SaaS Cloud Provider

Md. S. Q. Zulkar Nine, Abul Kalam Azad, Saad Abdullah and Rashedur M. Rahman (2015). *International Journal of Fuzzy System Applications* (pp. 50-71).

www.igi-global.com/article/fuzzy-dynamic-load-balancing-in-virtualized-data-centers-of-saas-cloud-provider/127311?camid=4v1a

Learning in Feed-Forward Artificial Neural Networks II

Lluís A. Belanche Muñoz (2009). *Encyclopedia of Artificial Intelligence* (pp. 1012-1017).

www.igi-global.com/chapter/learning-feed-forward-artificial-neural/10366?camid=4v1a

A Semantic-Enabled Middleware for Citizen-Centric E-Government Services

Ivo José Garcia dos Santos and Edmundo Roberto Mauro Madeira (2010). *International Journal of Intelligent Information Technologies* (pp. 34-55).

www.igi-global.com/article/semantic-enabled-middleware-citizen-centric/45155?camid=4v1a

Noise Resistant Morphological Algorithm of Moving Forklift Truck Detection on Noisy Image Data

Vladimir Olegovich Chernousov and Andrey Vladimirovich Savchenko (2014).

International Journal of Conceptual Structures and Smart Applications (pp. 36-54).

www.igi-global.com/article/noise-resistant-morphological-algorithm-of-moving-forklift-truck-detection-on-noisy-image-data/134887?camid=4v1a