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ORIGINAL PAPER

A hybrid SVM-FFA method for prediction of monthly mean global solar radiation

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Abstract In this study, a hybrid support vector machine–firefly optimization algorithm (SVM-FFA) model is proposed to estimate monthly mean horizontal global solar radiation (HGSR). The merit of SVM-FFA is assessed statistically by comparing its performance with three previously used approaches. Using each approach and long-term measured HGSR, three models are calibrated by considering different sets of meteorological parameters measured for Bandar Abbass situated in Iran. It is found that the model (3) utilizing the combination of relative sunshine duration, difference between maximum and minimum temperatures, relative humidity, water vapor pressure, average temperature, and extraterrestrial solar radiation shows superior performance based upon all approaches. Moreover, the extraterrestrial radiation is introduced as a significant parameter to accurately estimate the global solar radiation. The survey results reveal that the developed SVM-FFA approach is greatly capable to provide favorable predictions with significantly higher precision than other examined techniques. For the SVM-FFA (3), the statistical indicators of mean absolute percentage error (MAPE), root mean square error (RMSE), relative root mean square error (RRMSE), and coefficient of determination (R^2) are 3.3252 %, 0.1859 kWh/m^2, 3.7350 %, and 0.9737, respectively which according to the RRMSE has an excellent performance. As a more evaluation of SVM-FFA (3), the ratio of estimated to measured values is computed and found that 47 out of 48 months considered as testing data fall between 0.90 and 1.10. Also, by performing a further verification, it is concluded that SVM-FFA (3) offers absolute superiority over the empirical models using relatively similar input parameters. In a nutshell, the hybrid SVM-FFA approach would be considered highly efficient to estimate the HGSR.

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1 Introduction

Currently, solar energy is being broadly harnessed in various locations across the globe to enhance the sustainability and abate the prevalent environmental problems such as global warming and air pollution. On this account, various technologies have been invented in which solar energy can be utilized either directly or indirectly. Nevertheless, the availability of precise solar radiation data is a fundamental requirement for solar system specialists to successfully simulate, operate, and monitor the solar energy technologies for a variety of applications (Bannani et al. 2006; Mubiru et al. 2007; Mubiru and Banda 2007; Benghanem and Mellit 2014; Flores et al. 2015). Unfortunately, the reliable measured solar radiation data, even in the form of global solar radiation, are not accessible in many sites due to a series of obstacles including the required