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A classification mechanism for determining average wind speed and power in several regions of Turkey using artificial neural networks

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Abstract

In this paper, average wind speed and wind power values are estimated using artificial neural networks (ANNs) in seven regions of Turkey. To start with, a network has been set up, and trained with the data set obtained from several stations—each station gather data from five different heights—from each region, one randomly selected height value of a station has been used as test data. Wind data readings corresponding to the last 50 years of relevant regions were obtained from the Turkish State Meteorological Service (TSMS). The software has been developed under Matlab 6.0. In the input layer, longitude, latitude, altitude, and height are used, while wind speeds and related power values correspond to output layer. Then we have used the networks to make predictions for varying heights, which are not incorporated to the system at the training stage. The network has successfully predicted the required output values for the test data and the mean error levels for regions differed between 3% and 6%. We believe that using ANNs average wind speed and wind power of a region can be predicted provided with lesser amount of sampling data, that the sampling mechanism is reliable and adequate.

Keywords: Wind speed predictions; Artificial neural networks; Turkey

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1. Introduction

Wind, which is renewable and widely available power source found around the world, is the most popular energy source of green electricity and generally scarcely used for energy production. We, the human being have investigated the possibility of using wind as a source of energy for several years. The first attempts were initiated by the Persians and Chinese to grind grains at mills [1]. The production of electricity using the wind has been first realized through successful research efforts in 1960s in Denmark. The production of wind turbines has followed rapidly especially in the northwestern European countries, and spread quickly to other countries, resulting significant increases at number of wind turbines. The first professional usage of wind for electricity production was in 1973 by Europeans after the first oil shock in the mid-1970s. Nowadays, wind energy is becoming increasingly popular due to the harmful effects of fossil fuels on the environment [2]. Therefore, wind energy is a growing energy source in the world and is becoming one of the most widely used alternative sources of energy today. Approximately, 6500 MW of new wind energy generating capacity were installed worldwide in 2001 [3,4] and at the beginning of the year 2002, the total set up capacity of global wind energy surpassed 24,576 MW [3]. The set up capacity in Europe has increased by about 40% per year in the past 6 years. Today, wind energy projects across Europe produce enough electricity to meet domestic needs of millions of peoples [5]. The biggest share of global wind energy capacity is held by Europe with 72%. The European wind energy Association has a target of 60,000 MW of installed capacity by 2010 and 150,000 MW by 2020 [6].

There is a great need for the information about availability of local wind power across the world. This is required to answer the question of the possible amount of produceable energy. Wind atlases are prepared to show areas, which are potentially suitable for wind based energy production. They collate statistical data on regional mean wind speeds and power densities. Therefore, there is a need to prepare a guidebook, giving information on the quality and quantity of the wind power available in each country. Before the establishment of the wind turbines, a feasibility study need to be carried out, which gives information to the potential investors about the costs and economical aspects of a planned wind energy projects [7]. To make decisions, statistical and dynamic characteristics of the wind site should be evaluated using wind observations and statistical wind data [8]. Several studies have been executed to estimate the wind potential in different parts of the world [9].

Artificial neural networks have been used by some authors to estimate hourly approximate values wind power generators [10]. Due to the individual properties of wind sites, a meaningful approximation mechanism is required. The number of observation sites to obtain statistical data is important if we wish to obtain reliable data. However, this is a costly task. In this study, we investigated the possibility of using ANNs for such evaluations with lesser number of such sampling sites. In the study, wind data, taken from TSMS from different stations, have been collected to estimate wind speed of predetermined regions using ANNs. Therefore, we have