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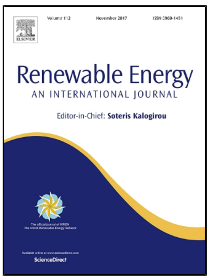

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ACCEPTED MANUSCRIPT

Adaptive Linear Prediction for Optimal Control of Wind Turbines

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Abstract- In order to obtain maximum power output of a *Wind Energy Conversion System* (WECS), the rotor speed needs to be optimised for a particular wind speed. However, due to inherent inertia, the rotor of a WECS cannot react instantaneously according to wind speed variations. As a consequence, the performance of the system and consequently the wind energy conversion capability of the rotor are negatively affected. This study considers the use of a time series *Adaptive Linear Prediction* (ALP) technique as a means to improve the performance and conversion efficiency of wind turbines. The ALP technique is introduced as a real time control reference to improve optimal control of wind turbines. In this study, a wind turbine emulator is developed to evaluate the performance of the predictive control strategy. In this regard, the ALP reference control method was applied as a means to control the torque/speed of the emulator. The results show that the employment of a predictive technique increases energy yield by almost 5%.

Keywords
Wind energy conversion systems; Wind turbine; Linear adaptive prediction; Power mapping technique; Wind speed sensor technique; Wind speed estimation.

1. Introduction

Growth in wind energy is at an unprecedented level. At the end of 2015 there was in excess of 433 GW of installed capacity (globally) [1], with wind energy supplying 3.7% of global electricity [2]. Indeed, the *Global Wind Energy Council* (GWEC) in their 2015 annual update, reported that the average annual growth (year-on-year) in wind energy capacity is 22% since 2000 [1]. The *International Energy Agency* (IEA) further emphasise the potential for wind energy by suggesting that 15-18% of global electricity will come from wind power by 2050 [2]. The growing trends in wind energy technology are motivating researchers to work in this area with the aim of optimising the energy extraction form the wind and the injection of quality power into the grid [3]. This growth is partly due to the technological improvement of wind turbines, which has led to significant decrease of wind power cost, allowing the energy source to compete with conventional generation methods [4].

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