Application of Median Filter in Coded Wireless References of a Predictive Wind DFIG Turbine

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I- Introduction

➢Wireless signals dispatched from a remote operations center to command wind turbines are prone to impulsive interferences. In this applied context, this paper proposes the use of a median filter to mitigate these impulsive interferences in a doubly-fed induction wind turbine. To a perfect proposal evaluation, a co-simulation with the wireless system model and the generator predictive control one is performed to observe the deleterious effects to be treated by the filter. The obtained results endorse the effectiveness of the filtering method in wind turbine wireless controlled applications.

➢Wireless communication is one of the cutting-edge technology steadily growing its presence in the grid operation and renewable energy. This fact is mainly due to the reliability, reduced costs, and easy setup of connection which it can provide. In this context, the smart grid concept is pushing for the widespread usage of wireless technologies and it can highlight the growing presence of smart wind turbines connected to the power grid.

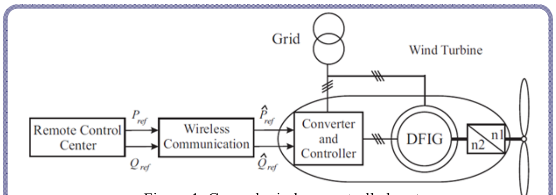

Figure 1. General wireless controlled system.

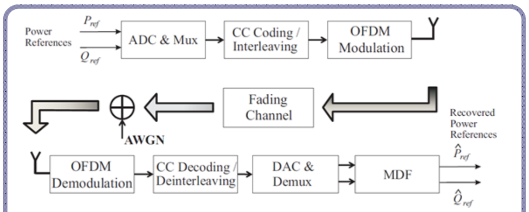

Figure 3. Block Diagram of Wireless communication system using MDF.

II. Machine Model And Predictive Control

➢In this system under test, the P and Q stator power are controlled directly. The Eq.s (1) present the expression of P and Q by using machine variables in the synchronous reference frame and by using stator flux orientation.

$$P = -\frac{3v_1 L_M}{2\sigma L_1 L_2}\lambda_{2q} \quad and \quad Q = \frac{3v_1 L_M}{2\sigma L_1 L_2}\left(-\lambda_{2d} + \frac{L_2}{L_M}\lambda_1\right)$$

➢The MBPC block diagram applied to the DFIG DPC is shown in Figure 2.

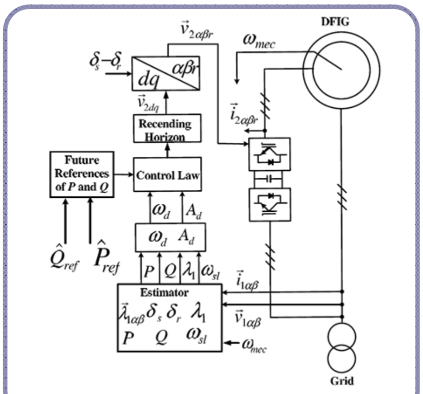

Figure 2. Block diagram of MBPC DPC strategy.

➢Finally, a quadratic cost function in terms of U, which gives the analytical optimal solution, is given by,

$$U = \left(H^T W_y H + W_u\right)^{-1} H^T W_y \left(w - P_{px} x(k) - D\omega_d(k)\right)$$

III. Fundamentals Of Wireless Communication With MDF

➢The developed coded wireless communication system is shown in Fig. 3 A Convolutional Coding (CC) was the chosen coding process.
➢It uses a code rate of 1/2, generator polynomials (171, 133), and a constraint length of 7 [15]. In the analysis are used frequency fading channels and with the purpose of improving the performance and reliability of the system, an Orthogonal Frequency-Division Multiplexing (OFDM) modulation was adopted.
➢The overall effect of this filter is to smooth the input signal. So, it can be applied to impulsive noise corrupting constant-level signals, as proposed in this paper.

IV. Analysis Of Results

➢The proposed DPC system for DFIG using wireless transmission and a MDF was simulated in MATLAB Simulink.The sampling time of MBPC is T = 0.5 × 10−4s, and the DFIG parameters are: R1 = 24.75 mΩ; R2 = 13.3 mΩ; Lm = 14.25 mH; Ll1 = Ll2 = 284 µH; J = 2.6 Kg · m2; PP = 2; PN = 149.2 kV A; VN = 575 V.

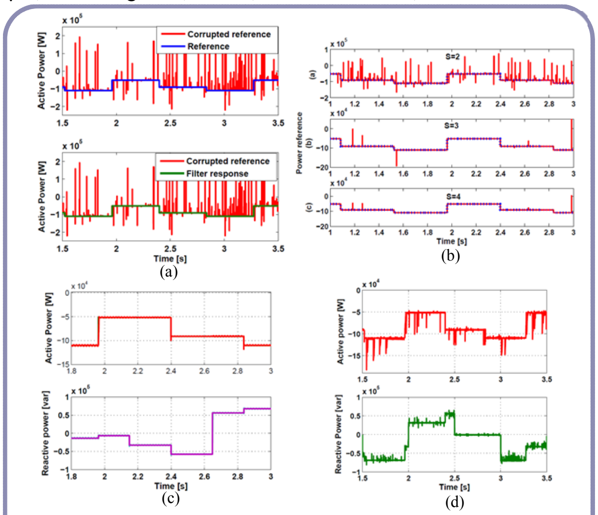

Figure 4. (a) and (b) MDF performance, (c) and (d) active and reactive power responses.

V. Conclusion

➢This work has introduced a filtering algorithm based on the MDF theory for improving the robustness of a MBPC applied to the DPC for a wind DFIG with regards the destructive effects of a wireless fading channel. This application is increasingly relevant in a smart grid scenario, where it is necessary to develop a complete telecommunications framework with a strong interaction. The proposed filter computes the median of a row of samples and mitigates impulsive interferences in control signals. The results show that the employment of the MDF allows filtering the spikes caused by the wireless communication received by the input of DFIG controller, without introducing any significant delay that compromises the system stability. In summary, the viability of the system operation using a wireless communication with MDF applied to wind turbine control is analyzed and proved, guaranteeing the physical integrity of the wind generator and the power quality delivered to the power grid.