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Maximizing the Power Output of Photovoltaic Systems Using Modified Power Point Tracking

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Abstract In this work, the water-filling system is proposed to calculate the energy is consuming of power allocation in OFDM-based cognitive radio systems. The conventional water-filling algorithm shows high complexity. To minimise this complexity and to minimise the energy-consuming, a simplified water-filling algorithm is modified. It was evident from extracted results that lowering complexity and minimising the energy-consuming will affect the performance of the system regarding the probability of error mainly. The proposed algorithm can be improved if the secondary multi-carrier system is considered instead of the initial allocation.

***Index Terms*—Energy minimising, OFDM systems, Cognitive Radio, Modified Water-Filling Algorithm**

I. INTRODUCTION

One of the most widely used techniques is the perturb & observe algorithm, which periodically perturbs the operating point of the PV array, sometime with an adaptive perturbation step, and compares the PV power before and after the perturbation [1].

Many maximum power point tracking (MPPT) techniques for photovoltaic (PV) systems are well established in the literature. The most commonly known are hill-climbing [2], fractional open-circuit voltage (Voc) control [3, perturb and observe (P&O) [4], and incremental conductance (IncCond) [5].

The MPPT techniques proposed so far in the technical literature can be classified mainly as Perturb & Observe (P&O), Incremental Conductance (IC), and Temperature Gradient (TG) techniques [6].

Several improvements on the P&O algorithm have been proposed in order to reduce the oscillations around the maximum power point (MPP) at steady-state, but all of them slow down the response speed of the algorithm when atmospheric conditions change and reduce the efficiency during cloudy days [7]. An adaptive MPPT algorithm for a field-programmable gate array has been proposed in [8]. This adjustable algorithm is based on an improved P&O method that does not need external sensory units. Despite its cost-effectiveness and high-speed processing, the system performance has been demonstrated to be outstanding

II. CONVENTIONAL WATER-FILLING ALGORITHM

Based on work [12], the power allocation of conventional water-filling (CWF) algorithm, can be expressed as

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$$P_*^n = \left(\frac{1}{\lambda} - \frac{N_0}{|h_n|^2} \right)^+ \quad (1)$$

Where λ is the Lagrange multiplier, and h_n is the channel gain for each subchannel with the total power constraint P_{total}. The optimum resolution if the Lagrange multiplier λ satisfies the condition

$$\sum_{n=0}^{N-1} \left(\frac{1}{\lambda} - \frac{N_0}{|h_n|^2} \right)^+ = P_{total} \quad (2)$$

Theoretically, The inverse of the Lagrange multiplier can be watched as a

water level. The water level can be originate by the binary search method [13].

To show the complexity of WFA in the next section, we will see the main properties of WFA. By discovering the properties of the water-filling, we propose a low computational complexity power allocation algorithm which requires performing only a single water filling calculation. This algorithm not only significantly reduces the computational.

III. PROPERTIES OF WFA

In [14], a simple and elegant water filling (GWF) approach is proposed to solve the unweighted and weighted radio resource allocation problems. Unlike the conventional water-filling (CWF) algorithm, it eliminates the step to bargain the water level through explaining a non-linear system from the Karush-Kuhn-Tucker conditions of the target problem. The proposed GWF requires less computation than the CWF algorithm, under the same memory requirement and sorted parameters.

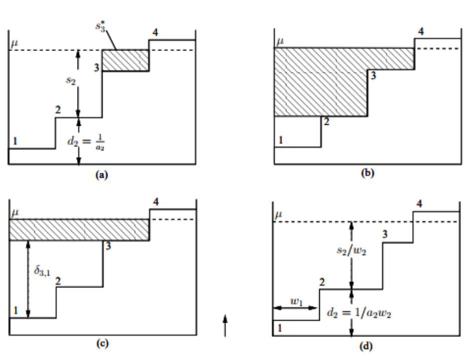

Figure 3.1: Illustration of the Geometric Water-Filling (GWF) algorithm. (a) Illustration of water level step k ∗ = 3, allocated power for the third phase s ∗ 3, and step/stair depth di = 1/ai. (b) Illustration of P2(k) (shadowed area, representing the total water/power above step k) when k = 2. (c) Illustration of P2(k) when k = 3. (d) Illustration of the weighted case [14].

IV. OFDM-BASED COGNITIVE RADIO SYSTEM

The radio spectrum is characteristically a scarce resource, especially in wireless communication networks. Moreover, recent studies have shown that the spectrum is not used optimally and spectrum scarcity is more due to ineffective policies in assigning the spectrum that restricts its use solely to authorised users. A promising approach to solve the spectrum scarcity is cognitive radio (CR) technology that proposes to allocate the spectrum to users dynamically. In CR, secondary users should regularly monitor a predefined frequency band assigned to licensed primary to detect vacant frequency opportunities, commonly referred to as spectrum holes, where this operation is called spectrum sensing [15], [16]. Noticeably, in practice, during the spectrum sensing process, it is essential for secondary users to reliably detect the primary user's signal to avoid interference from the secondary transmission to the primary network.

However, due to environmental conditions and transmission impairments, the spectrum sensing process is an imperfect process, i.e., its results have some uncertainties.

The Federal Communication Commission (FCC) has recommended geo-location and database access as an another to conventional spectrum sensing for TV band devices (TVBD) to access the accessible channels. However, conventional spectrum sensing is still needed for an optimal usage of the radio spectrum in future applications as suggested by the FCC [17].

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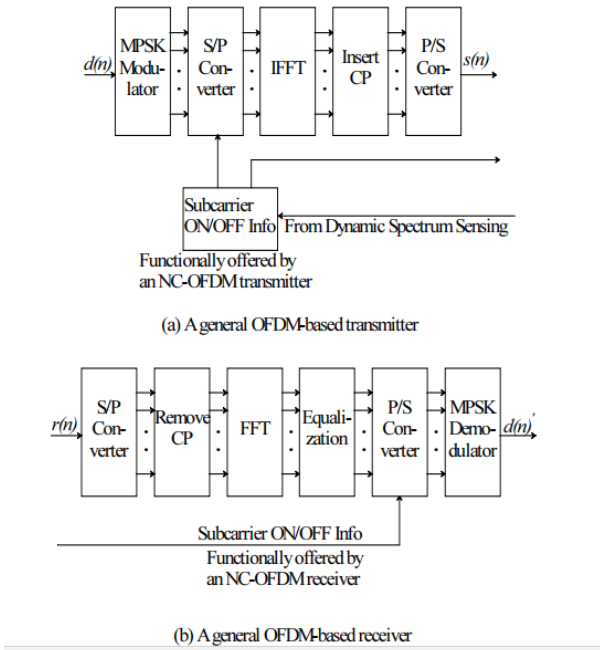

Figure 4.1: A general schematic of an OFDM-based cognitive radio transceiver.

The sidelobes resulting from the use of OFDM for representing the symbols of the low data rate streams are a source of interference to neighbouring transmissions in cognitive radio systems. There are already several techniques exist to suppress this high out-of-band radiation. However, none of them is efficient enough, and new techniques need to be developed to provide further reduction of OFDM OOB radiation.

V. NUMERICAL OUTCOMES

In this section, we extant the Matlab recreation results for OFDM based CR proposed algorithm. We assume the Added White Gaussian Noise (AWGN) noise density N0 and the number of subcarriers, M, For all subcarriers, advantage h_i is assumed self-determining and identically Chi-square distribution. In our simulations, we have a dissimilar number of PUs reaching from 1 to 40. We solution every subchannel with 32 subcarriers so that the total subcarriers variety from 32 to 1280.

The performance of the planned algorithm is evaluated in Fig.5.1. In Fig.5.1, the calculation time for the two kinds of algorithms is plotted. To show the precise increase of the calculation time, we practice the logarithmic rule for the Y axis. It is shown that the calculation time of proposed process is nearly 23 times faster than that of the IPWF algorithm [8].

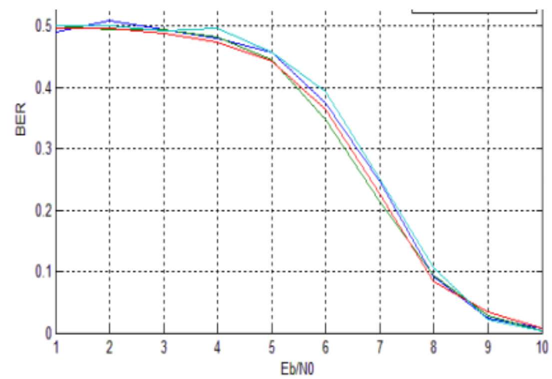

Figure 5.1. Computation time versus numbers of subcarriers for different power allocations

VI. CONCLUSION

In this work, we present different WF systems with the various complexities to minimize the energy consumption of multi-carriers in multicarrier systems. In this work, the water-filling system is proposed to calculate the energy is consuming of power allocation in OFDM-based cognitive radio systems. The conventional water-filling algorithm shows high complexity. To minimise this complexity and to minimise the energy-consuming, a simplified water-filling algorithm is modified. It was evident from extracted results that lowering complexity and minimising the energy-consuming will affect the performance of the system regarding the probability of error mainly. The proposed algorithm can be improved if the secondary multi-carrier system is considered instead of the initial allocation.

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