A Reduced Complexity of Space-Time Block Decoders for Aeronautical Telemetry

Yves LOUET[1]and Rami OTHMAN[1,2]

[1] IETR / CentraleSupélec, Campus de Rennes, Av. de la Boulaie, 35557 Cesson-Sévigné, France
[2] Zodiac Data Systems, 14000 Colombelles, France

In the recent years, the increased demand for high data rates, despite a limited available bandwidth for aeronautical telemetry, has driven the standardization committee IRIG to adopt new bandwidth efficient modulations. The shaped offset quadrature phase shift keying tier generation (SOQPSK-TG) is one of the standardized modulations that is actually replacing the legacy modulation Pulse Code Modulation/ Frequency Modulation (PCM/FM). It is a continuous phase modulation (CPM) distinguished by its ternary symbols and a long frequency pulse. Along with the modulation, aeronautical telemetry systems have also been evolved to increase the availability of the telemetry link. In fact, the first aeronautical telemetry systems used one transmitting antenna fixed underneath the aircraft fuselage and one receiving antenna on a fixed ground station. This scheme could be sufficient for aircrafts with smooth mobilities. Nevertheless, for some air vehicles such as fighter jets or missiles, the use of two transmitting antennas instead of one to guarantee an omnidirectional transmission has became mandatory. This solution could be efficient if the signals are sent using different carrier frequencies or when the receiver experiences Line of sight (LOS). However, if the same signal is sent simultaneously through both transmitted antennas with the same carrier frequency and that the two antennas are in LOS, the received signal could suffer from severe destructive interferences. This problem has been illustrated during some flight experiments [1,2] because the two-antenna system behaves like a single antenna array with an undesirable gain pattern, what degrades the telemetry link. This phenomenon is known as the ”two-antenna problem” in aeronautical telemetry.

The Alamouti encoder is a well-known space time block processing (STBC) for multi antenna systems used to improve the received signal quality while keeping reasonabe complexity at the receiver. However, when applied in the aeronautical telemetry context to solve the two-antenna problem, its benefits are shadowed by (i) the non linear characteristic of the used modulation (a shaped offset quadrature phase shift keying modulation) and (ii) the presence of a differential propagation delay between the paths. In this paper, we propose to reduce the complexity of the Alamouti decoder normalized in aeronautical telemetry thanks to the pulse amplitude modulation (PAM) decomposition of the signal [3]. We show that it successfully mitigates the differential delay effect, reduces the complexity by a factor of 8 compared to the state of the art and offers good bit error rate performance (Fig.1).

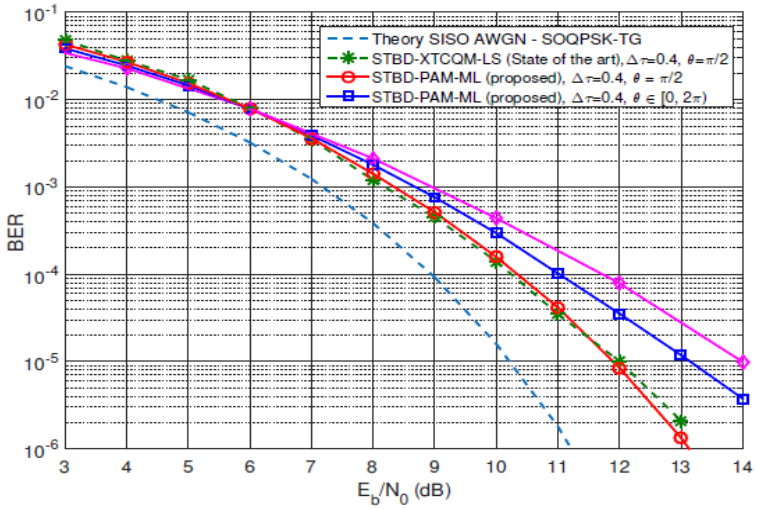

Fig. 1 : Performance of the proposed algorithm (differential delay $\Delta\tau$= 0.4 ; XTCQM : cross-correlated trellis-coded quadrature modulation)

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