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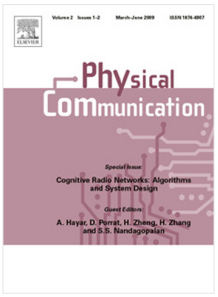

Generalized space modulation techniques: Hardware design and considerations

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Generalized Space Modulation Techniques: Hardware Design and Considerations

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Abstract

Generalized space modulation techniques (GSMTs), such as generalized space shift keying (GSSK) and generalized spatial modulation (GSM), activate a block of transmit antennas at one time instant to transmit the same data symbol. The aim is to allow the use of arbitrary number of transmit antennas not necessarily power of two. In this paper, novel generalized quadrature space shift keying (GQSSK) and generalized quadrature spatial modulation (GQSM) are presented and analyzed. It has been debated in the literature that these schemes require a number of RF–chains equal to the number of active antennas. In this paper, the design of the transmitters for all GSMTs with optimum number of required RF–chains are discussed and hardware limitations are briefly addressed. A general framework for analyzing the average bit error probability of all these systems is presented and shown to accurately predict the error performance over Rayleigh fading channels. Besides, receiver computational complexity, transmitter power consumption and a rough estimate on the hardware implementation costs for all these schemes are discussed and compared. It is shown that the transmitter implementation of all these schemes requires at most single RF–chain and in some cases no RF–chain is needed. In addition, it is revealed that GQSSK scheme outperforms all other systems and demonstrate the best error performance with low complexity, very low power consumption and modest implementation costs.

Index Terms

Generalized space modulation techniques; MIMO; Hardware implementation; Energy consumption; Cost; Receiver complexity.

I. Introduction

Space modulation techniques (SMTs) attracted significant research interest in the past few years [1]–[7], [21]. In SMTs, a new spatial constellation is invented, which is composed from the indexes of spatially separated transmit antennas. Incoming data bits modulate a spatial symbol that will be used to transmit either a modulated or un-modulated RF carrier signal at each particular time instant [5], [7], [9]. The different SMTs are thoroughly studied in literature and anticipated to require a single RF–chain transmitter with low computational complexity at the receiver and better error performance than state-of-the-art multiple-input multiple-output (MIMO) systems. Two families can be identified among the different SMTs. In particular, a family that

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