

B.Sundar Rajan

Professor

Department of Electrical Communication Engineering

Indian Institute of Science

Bangalore 560012

Email: bsrajan@ece.iisc.ernet.in

ABSTRACT

It is well known that the capacity of a fading wireless communication system increases considerably when multiple transmit and multiple receive antennas are employed (compared to single transmit and receive antenna systems). In such Multiple Input Multiple Output (MIMO) Communication systems Space-Time Codes (STCs) help to achieve a large fraction of the increased capacity. Orthogonal Frequency Division Multiplexing (OFDM) is the most favored modulation scheme to combat the problem of inter symbol interference in frequency selective channels and to achieve high spectral efficiency along with simplicity in implementation. When OFDM is employed in a MIMO system another dimension, viz frequency, is available for coding along with the space and time dimensions. Codes that exploit space, time and frequency are known as Space-Time-Frequency Codes (STFCs). The maximum diversity gain achievable using a STC is the product of the number of transmit and the number of receive antennas whereas the maximum diversity gain achievable with a STF code is the product of three quantities: the number of transmit antennas, the number of receive antennas and the channel length of the frequency selective channel. The maximum possible diversity of a STF code can also be achieved with coding across only space and frequency (not in time)- such codes are called Space-Frequency Codes (SFCs).

In this paper we present a survey of the known results concerning STCs, SFCs and STFCs and present some new constructions of SFCs and STFCs. We begin with describing the design criteria for construction of STCs, SFCs and STFCs and briefly discuss some well known constructions and classes of these codes. For STCs we discuss the trade offs between diversity gain, rate of the code, decoding complexity and the multiplexing gain. Several constructions giving high coding gains are also discussed. For SFCs and STFCs we present all the known constructions achieving full-diversity gains all of which are rate-one codes. Then we present a new class of high-rate SFCs STFCs that achieve full-diversity gain as well. An important aspect of SFCs and STFCs is the constellation precoding which is the key for achieving full-diversity gains. We will briefly discuss the known results concerning constellation precoding as well. Apart from several examples at every stage we will discuss elaborately the specific STCs, SFCs and STFCs that have been accepted for IEEE 802.11 and 802.16 Standards. We will conclude with a discussion on a number of open problems, both mathematical and practical in nature.