Preface

Millimeter wave spectrum (30-300 GHz) has the ability to provide a larger signal bandwidth. It can dispense signal bandwidth from 1-2 GHz, which is larger than IMT advance technologies aka 4G, (5-20 MHz). Evidently, larger bandwidth is capable of providing high transmission rate in wireless communications. In contrast, mmWaves suffer from high free space path losses, penetration losses, and absorption losses. But, the amalgamation of millimeter waves and multiple-input-multiple-output (MIMO) mitigate the losses by providing high directional beamforming.

It has been observed that multi-user MIMO (MU-MIMO) systems play an essential role in providing high throughput along with high directional beamforming. However, conventional beamforming techniques suffer from hardware complexity. Hence, such systems use hybrid beamforming, concatenation of digital and analog beamforming, to reduce the hardware to some extent. In addition, mmWave communications are unable to provide a rich scattering in the spatial domain owing to the high penetration and absorption losses and hence, lead to the channel sparsity. To exploit this channel sparsity, the channel model of mmWave MU-MIMO systems is transformed from spatial domain to beamspace domain by employing discrete lens array at the transmitter. Thus, it is known as mmWave beamspace MU-MIMO systems.

These systems are capable of generating orthogonal beams in the predefined angular direction and cover the entire angular region. But, it also suffers from radio frequency (RF) complexity because each beam requires a single dedicated RF chain for transmitting the data. In this thesis, the main issue which is of importance to reduce the RF complexity has been investigated.

Beam selection technique in such systems has been considered in thesis work to reduce the complexity and cost caused by the RF chains without affecting the most of the advantages of the system. A beam selection referred to as QR-based beam selection algorithm is proposed which can select an optimal set of beams for transmission in descending order depending on the logarithm of square of Eigenvalues of users' effective channels. Further, the dense and sparse systems are analysed with respect to the availability of users and the cell size. In this context, two low complexity beam selection algorithms are proposed. The first one is a greedy beam selection algorithm. The second one is a maximum weight matching based beam selection algorithm. Eventually, we evaluate the performance of the proposed beam selection algorithms.

Aforementioned proposed algorithms are deployed with centralized approach. It implies that the employed beam selection algorithm at the transmitter is to select beams by transmitter itself. In order to reduce the computation burden of the transmitter, a decentralized beam selection algorithm based on distributed auction algorithm is proposed, and compared its performance with the existing algorithms.

For each of these beam selection algorithms, a different precoding method is employed at transmitter in order to cancel the multiuser-interference at user's end rather than employing zeroforcing precoding. Therefore, it motivates to investigate precoding design separately. Unlike ZF precoding, the proposed precoding facilitates each user to experience a different effective channel and thus, improve the system performance by an optimal power allocation to each channel.

Aforementioned proposed algorithms are deployed to select one beam per user. It implies that number of RF chains required at the transmitter are equal to the number of users. Sometimes, multiple users demand for the same beam but the aforementioned algorithms assign distinct beam to each user and degrade the system performance. To avert this situation, non-orthogonal multiple access (NOMA) scheme in the power domain for such systems is employed. Consequently, it is reducing the RF complexity of the system. Further, we design a power allocation scheme for those users, who are assigned the same beam, to perform successive interference cancellation successfully at user's and, compare the performance of mmWave beamspace MU-MIMO-NOMA systems.