CHAPTER 1
INTRODUCTION

1.1 Background

Demand of mobile data is increasing exponentially over time. Large bandwidth, high data rate and good quality services become the primary needs of the user. The increasing demand for mobile data is not compensated with the availability of frequencies because it is not renewable. Multiple input multiple output (MIMO) techniques for wireless communications have been studied extensively over the past decade as a means of achieving significant capacity gains needed for supporting high-rate wireless broadband applications [9]. MIMO is the emerging technology for the next generation of wireless communication systems that can provide a high spectral efficiency, a wide coverage area, and increase the system capacity[10]

The main idea of massive MIMO is to get all the benefits of a conventional MIMO on a much grater scale[11]. A critical factor in the design and analysis of MIMO systems is the theoretical models which are used for representing the MIMO transceiver. One issue which has received less attention is mutual coupling, which occurs due to electromagnetic interactions between the antennas in both transmitter and receiver[2]. Because of this effect the available space for placing the antennas is highly restrictive.

Research on Massive MIMO began study with various schemes. In study [2] [10], Massive MIMO research modeled in cylindrical and linear shape at 2.6 GHz. From previous studies Massive MIMO system modeling entirely still using low frequency at 2.6 GHz. This frequency is not suitable for broadband technology because in the era of broadband IOT devices will use high frequency[7]. In this research, the antenna model implemented using high frequency at 60 GHz. The 60 GHz provide broadband wireless communication which gives high capacity, high data rate and wide bandwidth [3].

Future wireless communications for example broadband IOT will use the full-duplex single-channel (FDSC) system which the system is able to receive and transmit simultaneously on a single channel [2]. It will offer double throughput compare with any conventional system without additional spectrum. FDSC will minimize the bandwidth required [6].The problem of full-duplex single-channel system is self interference [6]. In [6] has investigated the effect of self interference for 4x4 MIMO system. Self interference occurs because MIMO system employs the multiple antennas to transmit signals on the same frequency which cause the strong interference signals at the receiving antennas on the same side[2].

1.2 Problems Definition

Problems to be raised in this study are:

1. Massive MIMO antenna requires MIMO coding with orthogonal approaching character and a high rate
2. The next generation massive MIMO systems use the same frequency to transmit and receive data, this cause self-interference effect that will have an impact on system performance
3. There are mutual coupling on massive MIMO antenna and be required optimal antenna configuration
4. Self interference and mutual coupling effect on the performance of massive MIMO antenna

1.3 Reference Tracing

Research on Massive MIMO began study with various schemes. In study Massive MIMO research modeled in [2] cylindrical and linear shape, with the number of antenna elements 128 and 128 for cylindrical shape for the virtual antenna linear antenna. In this study Massive MIMO antenna tested at a frequency of 2.6 GHz with outdoor environmental conditions LOS and NLOS. In [10] Massive MIMO with another schemes investigated. In [10] number of antenna element is 112 and can rotate horizontally for 16 positions. The frequency used is 2.6 GHz same as in [2]. In [11] the modeling antennas using a T shape with a total of 144 antennas and 18 sub-array antenna. The frequency used is 2.6 GHz. From previous studies Massive MIMO system modeling entirely still using low frequency at 2.6 GHz. This frequency is not suitable for future technology because in the era of IOT devices will use high frequency. The Massive MIMO transciever antenna model was introduce in this study. The antenna model implemented using 60 GHz and configurated to eliminate the mutual coupling effect.

In study [6] have investigated to cancel self-interference, the best performing prior design is obtained. The authors gain the inverse of the transmitted signal using a phase shifter with attenuator. The attenuator and phase shifter allow a modulator to control the angle and amplitude of a feed signal.In [6] also investigated the effect of self interference for 4x4 MIMO system. In this study investigate the effect of self interference for Massive MIMO transceiver antenna for range 10% until 100%.

1.4 Research Purposes

The purposes of this research are :

1. Modeling the MIMO Coding QOSTBC for Massive MIMO system
2. Observe the effect of self-interference for BER performance and channel capacity
3. Modeling the Massive MIMO antenna that can minimize the effect of mutual coupling, increase the performance of BER and channel capacity
4. Analyze the performance of the Massive MIMO antenna

1.5 Scope of Work

This research aims to design the massive MIMO antenna that has optimal performance in terms of BER and channel capacity. Self interference effects were observed going to see the effect on system performance. Some of the steps that will be taken are:

1. Modeling the Massive MIMO antenna with specifications:
   (a) Transmission over the 60 GHz band
   (b) Number of transmitter antenna $<$ receiver antenna
2. Configuration of antenna can minimized the effect of mutual coupling
3. Simulates the effect of self-interference for BER and channel capacity with the following specifications:
   (a) Range effect of self interference is 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100%
   (b) Transceiver node 2 transmitting the same information as transceiver node 1

1.6 Research Hypotheses

The Massive MIMO transciever antenna model using 60 GHz is expected to eliminate the mutual coupling effect by adjusting the distance between antennas more than λ [12]. The effect of self interference for Massive MIMO transceiver antenna will decrease the BER value [4]. The BER will decrease gradually when the SI value is increased. Self interference also affects the channel capacity which will degrade performance [4].