INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : **MOHIT MISHRA**

Roll Number : **156302008**

Programme of Study : **M.S.[Engineering] + Ph.D.** Dual Degree

Thesis Title: **Highly Compact and Low Mutual Coupling MIMO Antennas**

Name of Thesis Supervisor(s) : **Professor Rakhesh Singh Kshetrimayum**

Thesis Submitted to the Department/ Center : EEE

Date of completion of Thesis Viva-Voce Exam : 24-June-2023

Key words for description of Thesis Work :

SHORT ABSTRACT

Multiple-input multiple-output (MIMO) is an efficient technology that can meet the demands of the modern communication system, such as higher data rate and less probability of error in data transmission. However, there are issues associated with the deployment of multiple antennas on both the transmitter and receiver sides. One such major challenge is increased electromagnetic interaction between antenna elements in a compact MIMO system, leading to increased mutual coupling (MC) and antenna correlation coefficient (ACC). The increase in the MC and the ACC between closely packed antenna elements of a compact MIMO antenna degrades the performance of a MIMO communication system. Therefore, this thesis begins with an introduction emphasizing the relevance of MIMO communication systems, followed by a discussion of the cause of the MC and its impact on MIMO communications' performance. A detailed study of the existing MIMO antenna design methodologies is carried out. It includes electromagnetic band-gap (EBG) structures, defected ground structures (DGS), neutralization line (NL) technique, array decoupling surfaces (ADSs), and substrate-integrated waveguide-based MIMO antennas. Compared to NLs for MC reduction, EBGs & isolators require much more space between antennas to accommodate them. Two NL-based MIMO antenna designs are presented in this thesis. The first is a dual-band two-port MIMO antenna, while the second is a six-port MIMO antenna. The mutual coupling between antenna ports in the two-port and six-port planar MIMO antenna is reduced by connecting adjacent antennas through NLs. ADSs or superstrates employed in isolation enhancement are generally placed at a certain height above the antenna array due to the associated operating principle. Consequently, an additional layer gets added and increases the MIMO antenna profile. Furthermore, single negative (SNG) meta-grid lines (MGLs) are proposed for mutual coupling reduction. The SNG MGLs can reduce the MC in the two-port printed monopole MIMO antennas and the two-port MIMO DRAs with minor structural modifications. This technique of the MC

reduction between antennas neither necessitates extra space between antenna elements, unlike the EBGs and the isolators, nor the installation of additional layers such as the ADS, enabling compact design of two-port MIMO antennas. It is noted that the proper placement of a double-side copper cladded substrate between two half-split cylindrical dielectric resonator antennas (CDRAs) can reduce the MC significantly and provide a space-efficient approach for the MC reduction in MIMO DRAs. One such two-port half-split DRA with overall size miniaturization is presented in chapter 5. The substrate-integrated waveguide (SIW) cavity-based antennas possess a noteworthy feature of size miniaturization by employing fraction mode SIWs (half-mode, quarter-mode, etc.). In addition, SIW cavities are known for their low profile, ease of integration, and self-consistent electrical shielding. Hence, SIW-based MIMO antennas do not require extra decoupling units when designed carefully and can achieve MC below -15 dB with size compactness. One such sector-shaped compact $\pi/8$ partial SIW cavity antenna from the TM_{220} diagonal mode of the SIW cavity is designed. This design technique offers 61% size miniaturization compared to the SIW rectangular cavity in its complete mode configuration. The proposed radiator is used to design an 8-port SIW-based compact MIMO antenna in chapter 6. Furthermore, the performance of the above-mentioned multi-port antennas for MIMO communications has been described in terms of channel capacity loss, diversity measure, and sum rate loss. This thesis thoroughly investigated all the MIMO antenna designs with their operation and utility.