BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

Avalahalli, Yelahanka, Doddaballapura main road, Bengaluru-560064

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

KSCST SYNOPSIS

Of

46th Series of Student Project Programme (SPP)

Project Reference number: 46S_BE_3304

Title of Project: Development of Compact Patch antenna for MIMO Applications

College name: BMS Institute of Technology & Management, Department of ETE

Name of Guide & students:

Guide: Dr. Banuprakash R

Students: Ashish K S (1BY19ET013), Alfred Antony Thottan (1BY19ET004), Nikitha M (1BY19ET033)

Abstract: The objective of this study is to design compact patch antennas that operate in specific frequency bands and exhibit reduced mutual coupling. In general, multiband antennas are designed and built using one or more combination of the existing approaches such as slots, DGS etc. Developing miniaturized antennas without compromising on its performance has always been a herculean task. In this research work, the compact antennas with enhanced performance using the appropriate combination of slots, defective ground structure, meta-material and re-configurability has been developed using High Frequency Structure Simulator (HFSS) and validated through Vector Network Analyzer (VNA).

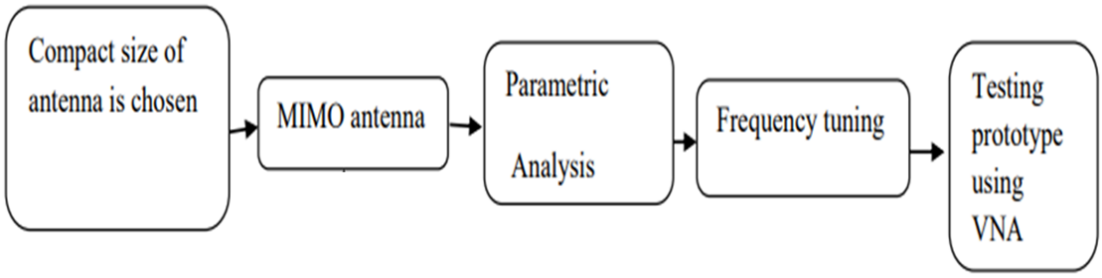
Keywords: Slots, DGS, MIMO application

INTRODUCTION: Wireless communication systems have undergone rapid development during recent decades. MIMO technology is widely used in wireless communication systems to enhance capacity and performance. Patch antennas are preferred for MIMO systems due to their small size, low profile, and ease of integration. It was observed in the literature that a blended methodology was used with an aim to enhance the performance of the antenna due to its unparalleled demand in the industrial applications. Novel designs of performance oriented compact antennas are expected to drive the wireless communication industry further with variety of portable compact devices. As a result, design of antennas by integrating various multiband methods is explored as part of the research work. In order to increase the capacity of a wireless 5G communication channel a single antenna element is not enough, this issue could be solve using MIMO. MIMO is effectively a radio antenna technology as it uses multiple antennas at the transmitter and receiver to enable a variety of signal paths to carry the data, choosing separate paths for each antenna to enable multiple signal paths to be used.

OBJECTIVES: In today's wireless communication era, all the devices have become portable and miniaturized. Because of growing technology of wireless communication where any component size has to be reduced obviously. Antennas play a vital and critical role in establishing the communication between transmitter and receiver. So basically, the size of the antenna should be reduced to make it suitable for portable devices. The age of miniaturization has brought in several advances in design of conformal microstrip antennas.

- To design an antenna for MIMO applications.
- Parametric analysis of designed antenna such as S11, Gain, VSWR, etc.
- To fabricate the antenna and validate the same using VNA.

METHODOLOGY:



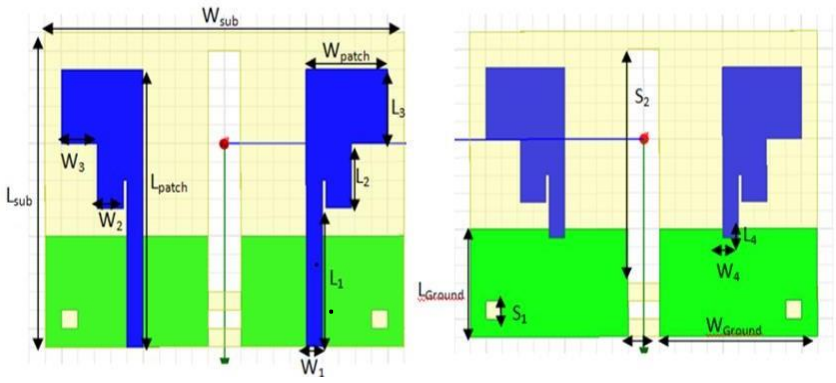
The methodology for design and development of an antenna depends on various techniques used to simulate different parameters of the antenna. The proposed antenna was designed using FR4 substrate. Slots are commonly used in antenna designs to enhance the antenna's performance, modify its radiation pattern, or achieve specific characteristics. A defective ground structure (DGS) refers to intentionally introduced irregularities or modifications in the ground plane or conducting surface near the antenna element. These modifications are strategically designed to improve the antenna's performance by suppressing unwanted radiation, reducing mutual coupling between antenna elements, enhancing impedance matching, or altering the radiation pattern. The major performance parameters such as antenna gain, bandwidth and return loss were observed.

- Design a single port microstrip antenna using HFSS.
- Incorporate multiple feeder inputs using HFSS simulator.
- Parametric analysis of the designed antenna for different parameters like Return loss, VSWR, Gain and Bandwidth.
- Fine tuning of the results using different approaches like slots, DGS etc.

Fabricate the antenna and validate the antenna parameters using Vector Network Analyzer (VNA).

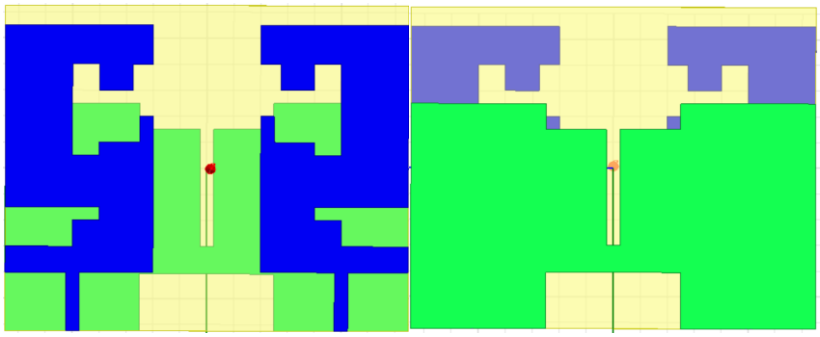
ANTENNA DESIGNS:

Development of 2 port antenna for multiband MIMO applications



A compact antenna is designed with the overall dimensions of size 22×17×1.6mm^3. The microstrip- fed patch antenna topology is to be an effective choice for the design of a compact 2 feed MIMO antenna for Satellite communication applications.

Development of compact 2 port MIMO antenna for sub 6GHz 5G applications



A 2 port antenna is designed with the overall dimensions of size 25×30×1.6mm^3. The microstrip - fed patch antenna topology is to be an effective choice for the design, The resonated frequencies are suitable for applications of 5G.

RESULTS AND CONCLUSION:

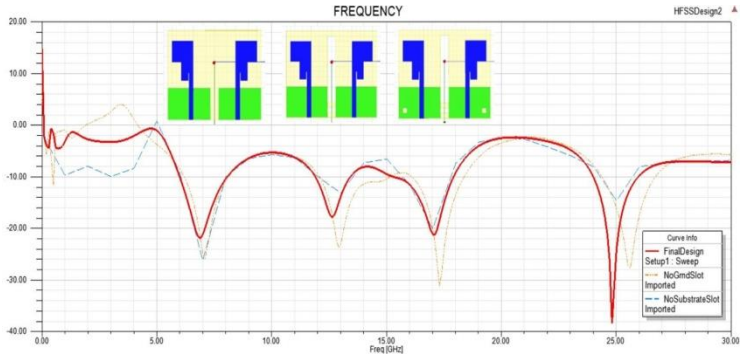


Figure 1 S_{11} plot of multiband antenna

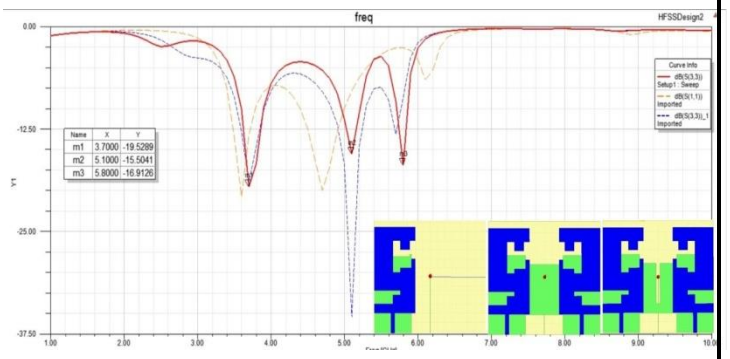


Figure 2 S11 plot of sub 6GHz 5G antenna

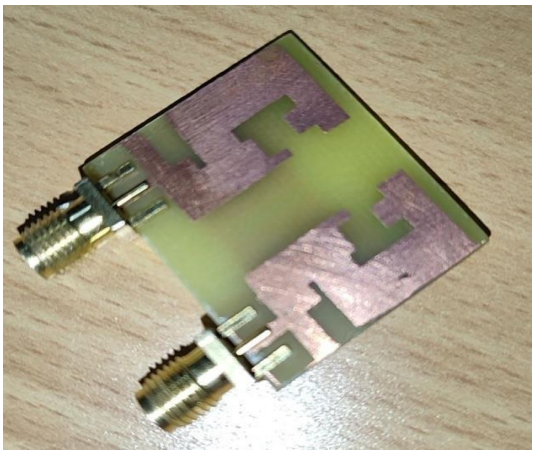
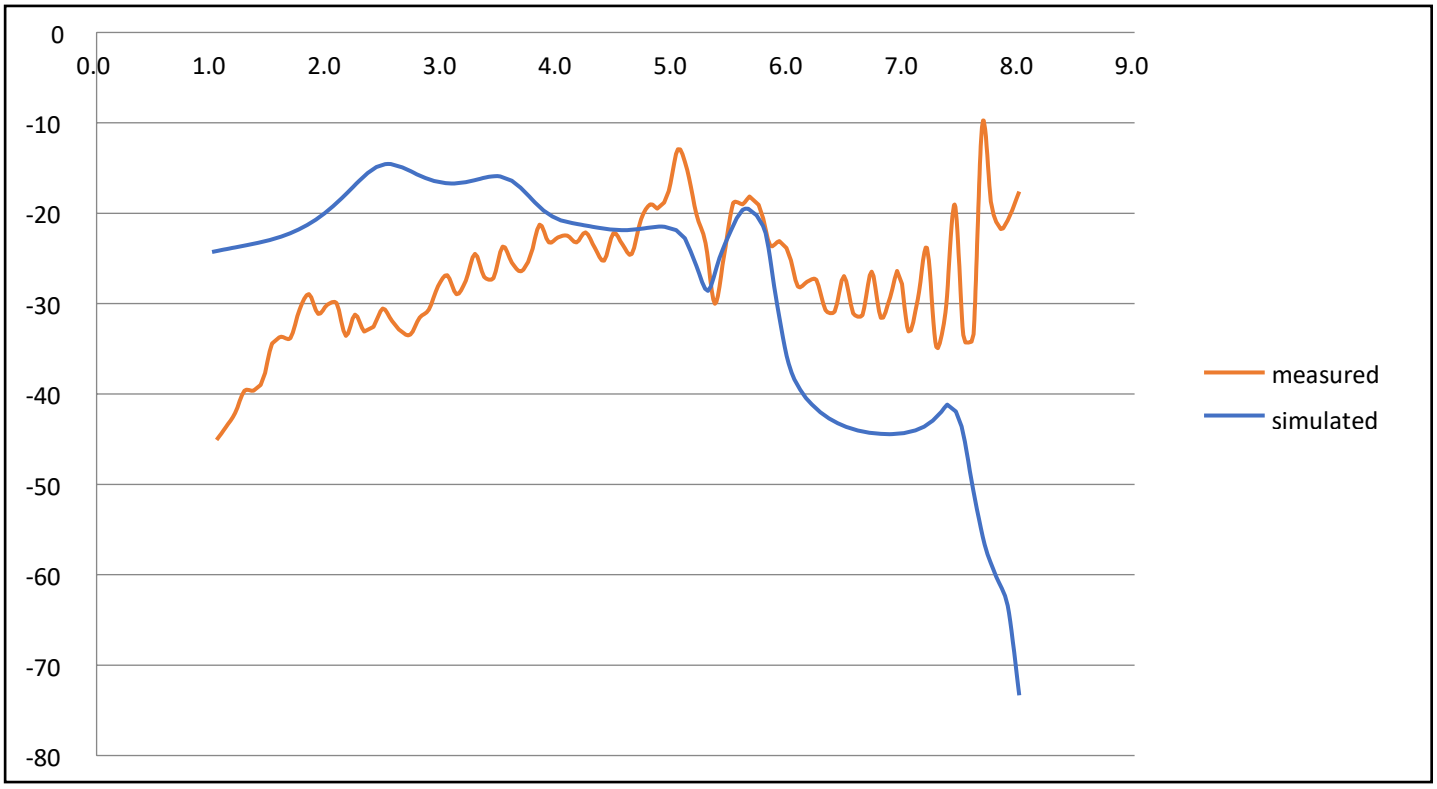


Figure 3 Fabricated MIMO antenna

Figure 4 Measured S_{21} of the fabricated antenna



A microstrippatch with DGS produced a quad band of frequencies 6.9GHz, 12.7GHz, 17.1GHz & 25GHz.Effect of slot on the ground to improve the return loss is observed. A gain of 4.7 dB, 13.6dB, 4.6 dB and 1 dB for respective frequencies are obtained.

The designed compact 2-port MIMO antenna for 5G applications offers a range of significant benefits. The use of slots on the patch contributes to better current distribution andproduced tri band frequencies of 3.1GHz, 5.1GHz & 5.8GHz with respective gain values of 22.8 dB, 14.1 dB & 13.3 dB. With a rectangular slot on ground helped in reducing the mutualcoupling of the antenna to desirable value of <15dB.

Our results showed that the proposed antenna design outperformed many existing designs in terms of bandwidth and isolation. The antenna also showed good radiation characteristics and low correlation between the two antenna elements. Further research could explore other optimization techniques, such as using advanced materials or non-uniform geometries, to further improve the performance of MIMO antennas. Overall, the design and simulation process for the proposed antenna demonstrates the importance of careful optimization and simulation to achieve high performance in MIMO applications.

SCOPE FOR FUTURE WORK:

The future scope of compact patch antennas for MIMO applications lies in expanding bandwidth capabilities, improving gain and efficiency, advancing miniaturization techniques, exploring wideband and multiband options, integrating with advanced technologies, tailoring MIMO systems for specific applications, and leveraging advanced manufacturing techniques.These advancements will drive the development of compact patch antennas and contribute to the evolution of wireless communication systems in terms of performance, functionality, and application-specific requirements.