UNIVERSITI TEKNOLOGI MARA

COMPACT MIMO ANTENNA WITH HIGH ISOLATION TECHNIQUE FOR 16GHZ APPLICATION

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ABSTRACT

Microstrip antenna is an antenna type that most researchers use for multiple input multiple output (MIMO) technology developments. However, some limitations need to be considered when using this type of antenna, such as this antenna has a narrowband characteristic. Currently, several designers have proposed their antennas to improve antenna bandwidth. Hence, proper antenna modifications are required to enhance the antenna's performance, especially for MIMO systems. Existing works on the MIMO antenna development mostly focus on reducing mutual coupling and improving isolation between antennas, and some conducted studies on the compactness of the MIMO antenna development for modern communication. While the focus has been on designing a compact antenna, a very minimal study has been done on works related to single element with multiport antenna designs. This research aims to develop a wider bandwidth of a single element and a MIMO antenna with lower isolation which is compact for 16GHz systems. The parametric study on the integration technique with parasitic elements through experimental validation was conducted to prove the findings. Furthermore, the present study also analysed the proposed antenna in the MIMO diversity environment through measurements and validations using numerical evaluation. Results showed that the single-element antenna produced an excellent gain of 6.7dBi and achieved a -10dB bandwidth of 916 MHz and 1459 MHz for design without and with parasitic improving of 60% operational bandwidth. These results indicate the effectiveness of using the parasitic elements in future antenna design to retain a good gain over a wide bandwidth. Next, the single-element antenna structure was used in the analysis of the 2-element MIMO antenna design. The measurement results indicated that the MIMO diversity performance analysis was -26.75 dB, better than its minimum requirement of -15 dB. The envelope correlation coefficient (ECC), diversity gain (DG), and mean effective gain (MEG) also showed acceptable results with 0.148, 9.86 and 0.104, respectively. All the MIMO diversity parameters were verified by simulation and measurement analysis. The final design, a compact dual-port with a single antenna structure, which is a new design miniaturization technique in MIMO has been studied well and validated with measurements and diversity analysis. Overall, these research findings have successfully proven that the proposed antenna integrated with parasitic elements has enhanced the antenna's isolation, bandwidth and compatness. In addition, the final results presented regarding the MIMO antenna integrated with parasitic structures may facilitate the improvement of future miniaturization of the MIMO antenna design.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Fourth Generation (4G) has been utilized worldwide in the past years due to its speed, coverage, and reliability advantages. However, an upgraded network is needed to support the growing internet access devices. Many of them require so much bandwidth to function that the existing technology is not sufficient anymore. The upcoming and arrival of the future or modern communication will be more critical that most users and communication companies will depend on. In the next few years, human technology will be found in everything that can give online access without boundaries. Hence, our modern technology is already succeeding in placing people in online and wireless communication applications. As stated earlier, to get things and places ahead of time is indeed crucial and challenging, hence it is the responsibility of our current skilled and experienced researchers to ensure that things are moving fast towards their directions by improvising the existing technology (Sanjay Kumar et al., 2016). As predicted by (News, 2021; Yaacoub et al., 2016), by 2030, some 50 billion connected devices will be in use worldwide, creating smart networks inside and outside homes.

The demand for a much higher capacity, lower latency, and energy efficiency in the wireless network worldwide always increases from year to year. In the meantime, while focusing on future communication to support wireless network needs, traditional wireless communication systems utilize a single element transmitter (Tx) and receiver (Rx). Due to the multipath effects, the single element Tx and Rx in the communication system will suffer from lower data rate, capacity, and coverage (Mobile, 2005). The multipath effects on the obstacles such as buildings and hills will scatter the waveform. It will downgrade the signal performance, making it become slow due to the long time duration to reach the destination, eventually fading, and reduces data speed.

With the rapid development of wireless communication, the high-performance of the modern communication system with low cost and high data rate has become a crucial requirement (M Habib Ullah, 2014). The modern communication aims to impact the world by connecting everything to everything else with zero latency and high speed. With these high-end requirements, multi-input multi-output (MIMO) has been