Faculty of Electronic and Computer Engineering

DESIGN OF COMPACT TRI-POLARIZED ANTENNA FOR MULTIPLE INPUT MULTIPLE OUTPUT (MIMO) SYSTEM

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Master of Science in Electronic Engineering

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DESIGN OF COMPACT TRI-POLARIZED ANTENNA FOR MULTIPLE INPUT MULTIPLE OUTPUT (MIMO) SYSTEM

PHOO KHO SHIN

A thesis submitted in fulfillment of requirements for the degree of Master of Science in Electronic Engineering

Faculty of Electronic and Computer Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016
DECLARATION

I declare that this thesis entitled “Design of Compact Tri-Polarized Antenna for Multiple Input Multiple Output (MIMO) System” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .................................................................
Name : .......................................................................
Date : ......................................................................
APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature : .................................................................

Supervisor Name : ...........................................................

Date : .................................................................
DEDICATION

To my beloved family
In recent years, wireless communication systems such as radar, navigation systems, video conferencing, medical applications, and others have been widely developed. In order to meet the miniaturization requirements of portable communication equipment, an antenna with compact size has received much attention. Regardless of the application, most of the modern wireless communication systems require high data rate and channel capacity. With these provocations, Multiple Input Multiple Output (MIMO) systems were introduced to provide efficient performance and combat multipath effects. The objective of this project was to design, simulate, and fabricate a compact tri-polarized antenna for MIMO systems with operating frequency of 2.4GHz. In this project, antennas were designed using the inverted suspended method where the FR4 substrate and copper ground plane were separated with an air gap layer. Modified L-probe fed was used for all antenna designs where the strip line was printed on the upper side of the FR4 substrate and connected to the coaxial probe for ease of fabrication. The rectangular patch was printed at the lower side of the FR4 substrate. First of all, single polarizations for linear polarized (Design A) and circular polarized antennas (Design B) were designed. Then, dual-polarized antennas (Design C) were designed. Lastly, a compact tri-polarized antenna (Design D) was designed with a combination of three different polarizations; including linear polarization (LP), left-handed circular polarization (LHCP) and right-handed circular polarization (RHCP). All the antenna designs were simulated using Computer Simulation Technology (CST) software. Single-polarized antennas, dual-polarized antennas and tri-polarized antennas were successfully designed and achieved design specifications. Based on the simulation and measurement results, the designed antennas covered frequency of 2.4GHz with reflection coefficient below -10dB. The simulated bandwidths of the designed antenna were more than 200MHz for the broadband specification. The simulated axial ratio result was used to determine the performance of polarizations, in which the axial ratio for linear polarized was above 3dB and the axial ratio for circular polarized was below 3dB. Overall, the reflection coefficient, total efficiency, directivity, gain, axial ratio, and bandwidth of compact tri-polarized antenna showed good responses. The measurement results were almost similar to the simulation results. Therefore, this compact broadband tri-polarized antenna that is capable of performing in three different polarizations is suitable to be applied in MIMO systems that require polarization diversity.
ABSTRAK

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4.53 Comparison of simulated and measured reflection coefficient for Design C4

4.54 Simulated total efficiency for Design C4

4.55 Simulated directivity for Design C4

4.56 Comparison of simulated and measured gain for Design C4

4.57 Simulated axial ratio for Design C4

4.58 Surface current for port 1 of Design C4 at different phases. (a) 0° (b) 45° (c) 90° (d) 135° (e) 180° (f) 225° (g) 270° (h) 315°

4.59 Surface current for port 2 of Design C4 at different phases. (a) 0° (b) 45° (c) 90° (d) 135° (e) 180° (f) 225° (g) 270° (h) 315°

4.60 Comparisons of simulated and measured radiation pattern of Design C4 for elevation plane at resonant frequency, 2.4GHz when Phi = 0°. (a) Port 1 (b) Port 2

4.61 Comparisons of simulated and measured radiation pattern of Design C4 for elevation plane at resonant frequency, 2.4GHz when Phi = 90°. (a) Port 1 (b) Port 2

4.62 Tri-polarized antenna with three inverted rectangular patch (Design D1)