AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics Engineering and Electrical Communications

Large Scale Multiple Antenna System

A Thesis submitted in partial fulfillment of the requirements of
Doctor of Philosophy
(Electrical Engineering)

by

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Master of Science
(Electrical Engineering)
Faculty of Engineering, AASTMT Cairo Branch, 2013

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Cairo, June 2019

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Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Electrical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract

Faculty of Engineering – Ain Shams University
Electronics and Communication Engineering Department

Thesis title: **"Large Scale Multiple Antenna System"** Submitted by: **Mohamed Fathy Mohamed Abo Sree Ali**

Degree: **PHD**

Providing inexpensive high data rate access presents many challenges to satisfy the ever-increasing capacity demand and quality of service. Large-Scale Antenna Systems has a potential to realize cost effective high data rate access solution to User terminals. Various designs of antennas operating at different frequency ranges are proposed, and studied to serve a large scope of applications including the 4G, Radar and other potential applications. A study of the evolution of the modern mobile technology will take place, starting with the 1st generation of mobile communication and going on through with the Second, third and fourth generation of mobile technology, reaching the new and futuristic technology of the 5th Generation. Also, studying the metamaterials, their classifications, the approached designs, the various applications and their advantages will take place. Besides that, the different feeding techniques of the microstrip is discussed.

The design, implementation and analysis of a Patch antenna with Different Fractal Shapes is proposed. Where a conventional patch antenna having a rectangular shape, and with dimension of 9.2 mm x 6.94 mm is fabricated. It is implemented on a FR-4 lossy substrate material with relative permittivity ϵ_r= 4.3, thickness of 1.6 mm and loss tangent of 0.025. It is fed using a microstrip line excitation technique with dimension of 6 mm x 3.11 mm. It operates over a frequency band from 8 GHz to 12 GHz with central frequency 10 GHz. The performance properties of the antenna such as resonant frequency, radiation pattern, and gain were examined by simulation. The design is implemented through CST microwave studio and measured through network analyzer.

In Addition, a design and fabrication of ultra-wideband leaky wave metamaterial antennas are suggested and reviewed. The design, analysis and fabrication of

conventional and Metamaterial leaky wave antennas and the effects of utilizing composite right/left handed structure on bandwidth, gain and beam steering are reflected. The antennas are simulated using the CST microwave studio, fabricated on Roger 5880 and measured using the network analyzer. There is a good agreement between the measured and simulated results, showing that the antenna could be used for radar applications and broadband wireless communications. A large bandwidth was attained. Thus, broadband leaky wave antennas are very attractive and useful for radar systems and future broadband wireless communications.

Moreover, an ultra-wideband microstrip antenna for 4G applications is presented. The antenna consists of dual elements, with a total size of 58 mm X24 mm. A decoupling circuit is added to the design; afterwards the spacing between the elements is adjusted. An element covers the range between 3.29 and 6.9 GHz, while the other covers the frequency range from 8.76 GHz to 13.27 GHz using defective ground. A total bandwidth of approximately 8.2 GHz was achievable and the minimum value of the return loss measured was around the -18 dB. The antenna's structure and the parametric study, including the reflection coefficients, gain, coupling and decoupling, will be discussed further in this work.

Finally, an inverted-F antenna is discussed to be implemented in the Radar application operating at the millimeter wave range. The design and analysis of the antenna is done using the CST software to study its parameters. Also, a scaled version of it is proposed in order to implement at lower frequencies, and measure it through the network analyzer. The feeding of the simulated Inverted-F antenna is done using a coaxial cable, while the antenna is executed on a Rogers 5880 Substrate, with height 0.381.

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