METAMATERIAL FILTENNA AT 2.4GHZ FOR BLUETOOTH APPLICATION

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ABSTRACT

Nowadays, modern technologies such as aerospace, medical electronics and communication systems requires reliability and accuracy to support a very large number of standards such as Bluetooth. Thus, there is a huge demand to have a bluetooth antenna that are both capable to have precise measurement and high reliability. Combination of filter and antenna or filtenna is an alternative solution in the RF frontend circuit to reduce the transmission losses. In addition, Metamaterials are materials typically engineered with novel or artificial structures to produce electromagnetic properties that are impossible to retrieve in nature. Metamaterials offer many advantages in electromagnetic applications from microwave to optical range, especially for the radiated-wave devices. Thus, in this project, a metamaterial filtenna at 2.4GHz for bluetooth application has been proposed and designed. It combines SRR band pass filter with MELC resonator antenna. All of the simulations are done using Computer Simulation Technology full wave simulator software. Then, we compared the proposed filtenna performances with conventional filtenna. From the simulation results, it can be seen that metamaterial filtenna has better performances in terms of higher antenna gain (5.44dBi) and low return loss (22.2dB).

ABSTRAK

Pada masa kini, teknologi moden seperti sistem aeroangkasa, elektronik perubatan dan komunikasi memerlukan kebolehpercayaan dan ketepatan untuk menyokong sejumlah standard yang sangat besar seperti Bluetooth. Oleh itu, terdapat permintaan besar untuk mempunyai antena bluetooth yang kedua-duanya mampu menghasilkan pengukuran yang tepat dan kebolehpercayaan yang tinggi. Gabungan penapis dan antena atau filtenna adalah penyelesaian alternatif dalam litar RF depan akhir untuk mengurangkan kerugian transmisi. Di samping itu, Bahan Metamaterial adalah bahan yang biasanya direkayasa dengan struktur novel atau buatan untuk menghasilkan sifat elektromagnet yang tidak mungkin diperoleh semula. Bahan metamaterial menawarkan banyak kelebihan dalam aplikasi elektromagnetik dari gelombang mikro ke julat optik, terutama bagi peranti gelombang radiasi. Oleh itu, dalam projek ini, satu metamaterial filtenna pada 2.4GHz untuk aplikasi bluetooth telah dicadangkan dan direka. Ia menggabungkan penapis pas band SRR dengan antena resonator MELC. Semua simulasi dilakukan menggunakan perisian simulasi gelombang penuh Teknologi Simulasi Komputer. Kemudian, kami membandingkan persembahan filtenna yang dicadangkan dengan filtenna konvensional. Dari hasil simulasi, dapat dilihat bahawa metamaterial filtenna mempunyai prestasi yang lebih baik dari segi keuntungan antena yang lebih tinggi (5.44dBi) dan kehilangan pulangan yang rendah (22.2dB).

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LIST OF ABBREVIATIONS

GPS	-	Global Positioning System
Hz	-	Hertz
Ghz	-	Gigahertz
MHz	-	Megahertz
LHM	-	Left Handed Materials
RHM	-	Right Handed Materials
DNG	-	Double Negative Materials
SRR	-	Split Ring Resonator
CRLH-TL	-	Composite Right Left Handed Transmission Line
RH TL	-	Right Handed Transmission Line
LH TL	-	Left Handed Transmission Line
dB	-	Decibel
dBi	-	Decibel with reference to isotropic
ZOR	-	Zero Order Resonance
BW	-	Bandwidth
MTM	-	Metamaterials
SIR	-	Stepped Impedance Resonator

LIST OF SYMBOLS

E	-	Electric Field
H	-	Magnetic Field
c	-	Speed of light
f	-	Frequency
n	-	Refractive index
Z	-	Impedance
X	-	Reactance
Y	-	Admittance
ε	-	Permittivity
μ	-	Permeability
ω	-	Resonance frequency
λ	-	Wavelength
γ	-	Complex propagation constant

CHAPTER 1

INTRODUCTION

1.1 Project Background

The Wireless communication system has encountered a revolutionary improvement throughout the decade due to inventions that related to wireless products. Among major wireless products today are Global Positioning System, mobile phone, and consumer electronics product etc. All of these products have bluetooth connection either for extended connection with other electronics appliances or data transfer .Since bluetooth connection is very important, it will be great if overall performance of bluetooth connection is improved especially on its hardware. In bluetooth frontend circuitry, filter and antenna are the most important components. Moreover, these two components usually are designed separately. This will increase the overall size of frontend circuitry and introduce a transmission loss.

It will be a remarkable achievement to have a compact module consist of both filtering and radiating characteristics. Combination of these two main components will influence both performance and size of frontend circuitry

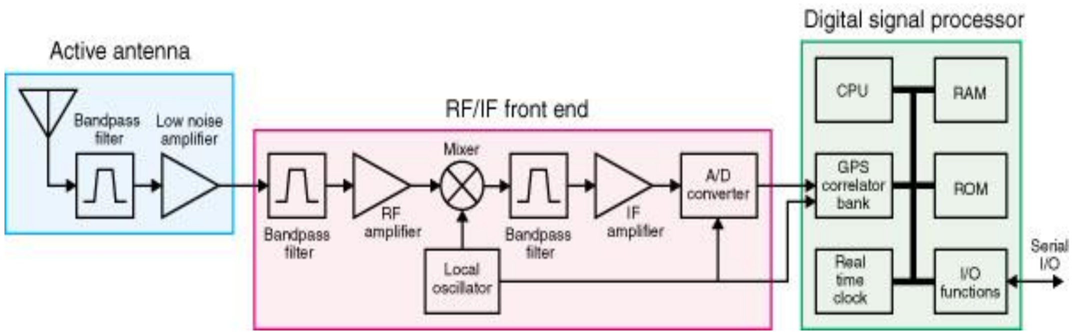

Figure 1.1 Frontend Circuitry

Metamaterials are artificial electromagnetic structures with unusual property not readily available in nature [1]. They are made from multiple elements arranged in repeating patterns at size that are smaller than the wavelengths of the phenomena they influence. As this arrangement, introduce a new structure, so does their properties. With a precise geometry, shape, size, orientation and arrangement give the newly arranged structure capability to manipulate electromagnetic waves. Among the highlighted capabilities are, blocking, absorbing, enhancing, or bending waves which ultimately has gone beyond what is possible with conventional materials. The history of metamaterials started in 1968 with the visionary speculation on the existence of substances with simultaneously negative values of ε and μ by the Russian physicist Viktor Veselago [2]. He pointed out no natural materials exhibit both negative electric permittivity and magnetic permeability. This project proposes a design of compact metamaterial filtenna to improve the overall performances.

1.2 Problem Statements

Separate design of filter and antenna at bluetooth frontend circuitry will make the circuit bigger and introduce transmission loss. By combination of filter and antenna at frontend circuitry, the overall size and transmission loses will be reduced. In addition, the filtenna model will use a metamaterial structure since metamaterial has proven to reduce overall size of microwave structure [3], [4]. In, addition, it also can improve the filter and antenna performances [1].Hence, the outcome for this project is to produce a compact and high performance filtenna at bluetooth frequency, 2.4 GHz.

1.3 Objectives

The objectives of this project are:

a) To design metamaterial filtenna at 2.4GHz
b) To compare the performance of metamaterial filtenna with conventional filtenna at 2.4GHz

1.4 Scopes of the project

In order to achieve the objectives of this project, there are guidelines need to be followed. Firstly, all the metamaterial characteristics will be studied. Next, using Computer Simulation Technology (CST) to design and simulate metamaterial bandpass filter and antenna that both operate at 2.4 GHz. After optimizations, next is to combine the metamaterial bandpass filter and antenna into one structure. This newly metamaterial filtenna will be compared with the conventional antenna to determine its overall performance.

1.5 Report Outline

This report is organized in five chapters. Chapter 1 gives an overview and the introduction of the project. Chapter 2 discusses the literature review on the definition, basic principle of metamaterial, metamaterial bandpass and metamaterial antenna. Chapter 3 covers the design methodology of the project. In this chapter the overview of the design and all the tools and modules used in the project are discussed. The outcomes of the project are then explained. Chapter 4 explains and analyzes the simulation results. Finally, chapter 5 covers the conclusion and potential future works that available for this particular research.

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