Sensitivity Assessment of Human Body Fluids through PCF-Based Plasmonic Biosensor for Biomedical Applications

Ayushman Ramola
Dept. of ECE
Sant Longowal Institute of Engineering and Technology (SLIET)
Longowal, Sangrur, Punjab
*xlayushman@gmail.com

Surinder Singh
Dept. of ECE
Sant Longowal Institute of Engineering and Technology (SLIET)
Longowal, Sangrur, Punjab
surinder_sodhi@rediffmail.com

Anupma Marwaha
Dept. of ECE
Sant Longowal Institute of Engineering and Technology (SLIET)
Longowal, Sangrur, Punjab
marwaha_anupma@yahoo.co.in

Abstract— **Different types of liquids are present in the human body. These liquids are known as body fluids. These fluids include urine, sweat, saliva, breast milk, cell fluid, *etc.* These body fluids possess unique properties that can be used as a testing fluid to identify various types of diseases present in human beings. Body fluids have an unique refractive index (*RI*) value for a healthy person. A change in the *RI* value is identified when a person gets infected with some disease or disorder. This study presents the scope of body fluid testing through spectroscopy analysis and *RI* sensing for biomedical applications. Photonic crystal fiber (*PCF*) based biosensors have revolutionized the sensor industry. Since they are susceptible to various factors and can be used for multiple body fluid analysis, thus, this work presents a brief background of spectroscopy measurement of liquid analytes and biosensor modeling.**

Keywords— Body fluids, refractive index, spectroscopy analysis, photonic crystal fiber, biosensors

I. INTRODUCTION

Different photonic sensing setups are developed in optics and communication to analyze various liquid samples. These sensing setups can analyze samples, such as solids, liquids, semisolids, *etc*. Some basic sensing setups based on the light photons principle include "displacement and curvature sensing setup [1]", "curvature sensing setup [2]", three-beam path Mach–Zehnder interferometer [3]" setup, *etc.* These setups are based on the spectroscopy analysis of the various components, which may be solids or liquids. Besides optical sensing, a new technique based on the analyte interaction through photonic crystal fiber (PCF) and surface plasmon resoance (SPR) have been widely spread. In this technqiue a $PCF\ SPR$ based sensor is created and developed which can interact with various inflowing analytes, a fluid body samples for analyte detection are performed. In this paper, different techniques for the analysis of human body fluids are analyzed and studied. Some of the prominent methods involving the use of spectroscopy for fluid body analysis are present in these reviews.

Blum et al. [4] developed a soft X −ray based spectroscopy end station to analyze various liquids and semisolid components present in the cells of human beings. *Jablonski et al.* [5] used Auger electron spectroscopy (AES) techniques to determine the composition of the surface of four different solids, *i.e.* (Si, Au, Ag, and Cu). *Wu et al.* [6] performed silicon surface quantitative surface characterization of 28 Si surfaces using the developed "$X-$ ray photoelectron Spectroscopy" system. *Reshchikov et al.* [7] used the "photoluminescence (PL) technique" to estimate the content of carbon in the "GaN" grown by "hydride vapor phase epitaxy ($HVPE$)." The PL data is obtained from the "secondary ion mass spectrometry ($SIMS$)" technique. *Wang et al.* [8] performed a quantitative analysis of the "Homocysteine ($C_4H_9NO_2S$)," is an version of the "amino acid" which is dangerous to the humans and can cause cardiovascular disease, fractures, and senile dementia in the THz region. The proposed analysis presented much higher values of the correlation coefficients, *i.e.,* 0.99809, than the Raman spectrum, thus producing an accurate evaluation for the pathological stage.

Generally, in the sensing system developed till today. Performed sample analysis based on "transmission (%)" and "absorbance (AU)" of the investigating solution. These systems' limitations are that they cannot provide any information about the solid samples. Thus only liquid sample solutions are analyzed from the conventional sensing system. For the test samples for the proposed approach, human fluids are identified for the investigation. Four human body fluids are among several body fluids which are selected due to their easy acquisition ability. The sample body fluids consist of blood, urine, saliva, and sweat. The body fluids are investigated within the wavelength range of $200\ nm$ to $1200\ nm$. The spectroscopy-based sensing system generally consists of five major components and some supporting components. Depending on the application type, these components are a light source (halogen, deuterium, or UV light source). The sample testing setup consists of a sample compartment, sample holder, spectrometer, optical fiber, and a USB cable for data transfer. Some minor components include power supply plugs and a computer system for result analysis.

It is important to note that several materials can be used as sample holders for the sample analysis despite the glass and plastic sample holders. Quartz material is highly durable and thus is preferred over other materials. It is also wholly inert and therefore does not participate in interaction with the body fluid sample [9]. In most research experiments, "stabilized tungsten halogen tube" is used as the source of light. It can work in the wavelength ranging from $200\ nm$ to $1200\ nm$ and can produce good analysis results at an operating temperature range of 4.5^0C to 35^0C. The sample

Ref. #AUGN/IC3I/2022/56241/001

AMITY UNIVERSITY | IEEE

5th INTERNATIONAL CONFERENCE ON CONTEMPORARY COMPUTING AND INFORMATICS (IC3I-2022)

14th - 16th Dec, 2022

Certificate of Participation in Research

We acknowledge the participation of Dr./Mr./Ms. **Ayushman Ramola** of **Sant Longowal Institute of Engineering and Technology** for the Research Paper presentation held during 5th International Conference on Contemporary Computing and Informatics (IC3I-2022) at Amity University Uttar Pradesh, Greater Noida. The paper titled **Sensitivity Assessment of Human Body Fluids through PCF-Based Plasmonic Biosensor for Biomedical Applications** was worth appreciating for its efforts in generating, analyzing and presenting research content.

Prof.(Dr.) Ajay Rana
Conference Chairperson &
Director General
Amity University Uttar Pradesh
Greater Noida

ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/350990704

Design of electromagnetic absorbers based on green nanomaterials

Chapter · January 2021

DOI: 10.1016/B978-0-12-822516-5.00022-8

CITATIONS
0

READS
41

4 authors:

Surekha Rani
Sant Longowal Institute of Engineering and Technology
13 PUBLICATIONS **16** CITATIONS
SEE PROFILE

Anupma Marwaha
Sant Longowal Institute of Engineering and Technology
110 PUBLICATIONS **866** CITATIONS
SEE PROFILE

Sanjay Marwaha
Sant Longowal Institute of Engineering and Technology
76 PUBLICATIONS **381** CITATIONS
SEE PROFILE

Murthy CHAVALI
Alliance University
300 PUBLICATIONS **4,824** CITATIONS
SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Project Exploring novel nanomaterial absorbers View project

Project Nanomaterials as sensors, Nanocomposites, Advanced Polymer Systems, Composites, Hybrids -Applied areas View project

Design of electromagnetic absorbers based on green nanomaterials

22

Surekha Rani[a], *Anupma Marwaha*[a], *Sanjay Marwaha*[a], *Murthy Chavali*[b,c,*]
[a]Electrical and Instrumentation Engineering Department, Sant Longowal Institute of Engineering & Technology, Sangrur District, Punjab, India [b]Aarshanano Composite Technologies Pvt. Ltd., Guntur District, Andhra Pradesh, India [c]NTRC, MCETRC, Tenali, Guntur, Andhra Pradesh, India
*Corresponding author.

22.1 Introduction

With the advancement of wireless technology, the living standard of human being has been raised undoubtedly, but it makes the environment polluted with electromagnetic waves. These harmful electromagnetic waves not only intervene in the performance of electronic equipment but also degrade the quality of human life. Due to the adverse effect of these harmful radiations, several chronical diseases come into existence. Further, the impact of EM waves on wildlife is also a challengeable issue because of these radiations certain birds' species have been extinct. Therefore, designing the green nanomaterial-based electromagnetic absorber can be the potential solution to this problem. Moreover, in the case of antenna arrays, the signal gain and directivity has been improved as the number of array elements increased. But with an increase of array element, the transmission of EM wave from one element to neighboring element increases called mutual coupling effect, which ultimately raises the side lobes of an antenna array. These side-lobes interfere with the main lobe signal.

Placing the absorbing device in-between array elements significantly reduces the mutual coupling effect, thus can decreases side lobe levels below −10 dB at which these side lobes will no longer interfere with the main beam. Also, for laboratory testing of an antenna or any other microwave system, an anechoic chamber must be required. The walls, ceiling and flooring of the anechoic chamber is covered with EM absorbing materials converting it into virtual free space where the reflections from side walls are almost negligible [1–5]. In addition to above, for concealment of an object from radar detection, which is the major requirement of stealth technology, the surface of the object must have coated with radar absorbing material. For providing radio frequency (RF) shielding in-between electronic components, EM wave absorbers can be used [6,7].

ScienceDirect

Handbook of Greener Synthesis of Nanomaterials and Compounds
Volume 2: Synthesis At the Macroscale and Nanoscale
2021, Pages 487-502

Chapter 2 - Green nanomaterials: pioneering approach toward hyperthermia treatment

Alka Singla [a], Anupma Marwaha [a], Sanjay Marwaha [b], Murthy Chavali [c, d]

Show more

Outline | Share | Cite

https://doi.org/10.1016/B978-0-12-822446-5.00021-6

Get rights and content

Abstract

Hyperthermia is a promising technology for the treatment of cancer in conjunction with surgery, radiation, and chemotherapy offering the advantage of targeted and localized impact on damaged tumor tissues, thus allowing a higher rate of destroying cancerous cells by delivering microwave power using interstitial and external applicators. Nowadays, usage of nanomaterials has radically advanced in the field of biomedical research for nanomedicine and drug delivery, particularly exploring the biodegradable nanomaterials exhibiting the properties such as controlled, stimuli-responsive release capabilities with excellent biocompatibility. The new opportunities stem primarily from the novel nature of nanomaterials, which exhibit typical physical and chemical properties as compared with conventional materials. Experiments on photohyperthermia technology performed for the treatment of cancer have been reported earlier.

Different types of nanomaterials commonly explored for photohyperthermia include carbon nanotubes (CNT's), graphene, gold nanoparticles, organic dye-based cyanine, porphyrin, and polymer nanocarrier. However, for microwave hyperthermia, the use of nanomaterials is still under research. Several challenges hyperthermia is inaccurate targeting, an undesired backward heating problem along with antenna, which leads to damage the surrounding healthy tissues and a nonspherical shape of heat lesion. To address these issues, this chapter aims to introduce nanomaterials as a promising agent for improving the efficiency of hyperthermia.

The manufacturing methods for current nanomaterials, however, use exceedingly toxic chemicals or elevated energy inputs during the synthesis, hence lead to hazardous environmental damage. Nanomaterials have not received much attention in terms of making their products sustainable and green. The new techniques to produce advanced nanomaterials in a green way, therefore, carry great potential for hyperthermia treatment.

Previous Next

Keywords

Green chemistry; Green nanomaterials; Heat lesion; Hyperthermia; Photohyperthermia

2021 IEEE 2nd International Conference on Electrical Power and Energy Systems (ICEPES)
MANIT, Bhopal, India. Dec 10-11, 2021

2021 IEEE 2nd International Conference On Electrical Power and Energy Systems (ICEPES) | 978-1-6654-0236-1/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICEPES52894.2021.9699509

Optimizing the Position of Graphene Oxide Absorber to Enhance the Radiation Pattern of Antenna Array

Dr. Surekha Rani
Assistant Professor, ECE department
Chandigarh University,
Mohali, India
surekhagarg9@gmail.com

Dr. Anupma Marwaha
Professor, ECE department
SLIET Logowal,
Sangrur, India
marwaha_anupma@yahoo.co.in

Dr. Sanjay Marwaha
Professor, EIE department
SLIET Logowal,
Sangrur, India
marwaha_sanjay@yahoo.co.in

Abstract: **Placement of electromagnetic wave absorber in vicinity of radiating elements will undoubtedly affects the radiation pattern of array. Variation in beam pattern of array depends on position of absorber and accordingly it can enhance or deteriorate the array pattern. Altering the major lobe axis of array structure due to action of absorber degrades the array performance while supressing the back lobe and side lobes of array without effecting major lobe increases front to back ratio of array resulting enhancement in array directivity and gain. In this paper, effort has been done to find out the best position of electromagnetic absorber to improve the array pattern by means of increasing gain and directivity and supressing the levels of sidelobes. A graphene oxide based absorber which is compatible with circular patch antenna array has been designed first. Further the proposed absorber is integratedon the same substrate but at the different positions of antenna array. The radiation pattern in each case has been analysed and the optimum position has been proposed on basis of increased array gain, directivity, sidelobe level reduction while maintaining pattern symmetry.**

Keywords: nanocomposites, graphene oxide absorber, reflection coefficient, antenna array, radiation pattern.

I. INTRODUCTION

An antenna array having extremely directive pattern is the utmost requirement for a wireless communication system [1] because it leads to targeted transmission and reception of information signal [2]. The directivity of array system increased by increasing number of array elements, but it also generates side lobes due to the mutual coupling effects [3,4]. The number of side lobes and their levels are proportional to number of array elements [4]. The side lobe levels greater than -10 dB interferes the major lobe signal and degrades the array performance [5]. Researchers working in the field of electromagnetics, proposed different algorithms and computer programming based codes which sense the variation in phase and amplitude of current excitation given to array elements due to interelement waves and accordingly an error signal will be generated which forcefully correct the element excitation using attenuators and phase shifters [6-8]. These methods are efficient to control sidelobe levels but required extra hardware for implementation [6]. Integration of microwave absorbers with antenna array on same substrate could provide an alternate approach to supress the side lobes of antenna radiation pattern [9]. This approach is very cost effective and industrial compatible as it does not require any extra firmware for implementation. But in this technique, if absorber is placed randomly near antenna element, then it can also distort radiation pattern of array by supressing major lobe. Therefore, for implementing this technique, position of absorber is the prime constraint which must be optimized for efficient working of antenna array.

In the proposed work, a graphene oxide based absorber in X band has been designed. Transmission and reflection coefficient graphs has been plotted for validation of proposed absorber. After that the absorber is integrated at the left side, right side, at corner and at both sides of antenna array. Radiation pattern has been plotted and it has been analysed that lobes whether side lobes or major lobesare supressed in each case depending upon absorber position. From comparison plot it has been observed that absorber integrated at both side of antenna array supressing the magnitude of both side lobes in very symmetric manner while the absorber placed at left side or right side supress their respective lobes only. Absorber at corner position effects the major lobe axis which is not desirable. Therefore, the absorber at both sides of antenna arrayis the most suitable position which enhance radiation pattern of antenna array in terms of increased array gain, directivity, reducing side lobe levels at both sides without distorting pattern symmetry and direction of major lobe.

II. ABSORBER GEOMETRY

Microwave absorber proposed here is made from graphene particles which are blended in epoxy resin material. The thickness of absorbing layer is calculated using quarter wavelength principal to work in X-band and it is equals to 1.5mm. A glass layer of height 1mm is placed back to absorbing layer. The whole geometry has been terminated by perfect electric conductor (PEC) sheet which ensures maximum reflection. Relative dielectric constant of absorbing layer is 20.4 and 0.18 is the loss tangent particularly at 10 GHz [9].

Quarter wavelength ($\lambda/4$) principle [10,11] is represented in equation 1, which gives the relationship between absorber dimension (d) and resonant frequency (f_m) is:

$$d = \frac{n\times\lambda_g}{4} = \frac{n\times c}{4\times f_m\times\sqrt{(\varepsilon_r\mu_r)}} \quad (1)$$

where d=dimension of absorber particularly thickness; λ_g is wavelength of incident wave = $\lambda/\sqrt{\varepsilon_r\mu_r}$; n: any integer (n= 1,3,5.....); c: velocity of light in vacuum; $\varepsilon_r and \mu_r$ are relative dielectric and magnetic constant of absorbing layer. Figure 1 shows the reflection (S11) and transmission coefficient (S21) graphs of proposed absorber with reflection coefficient dip of -81.71 at 11 GHz [9].

2021 IEEE 2nd International Conference on Electrical Power and Energy Systems (ICEPES)
MANIT, Bhopal, India. Dec 10-11, 2021

2021 IEEE 2nd International Conference On Electrical Power and Energy Systems (ICEPES) | 978-1-6654-0236-1/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICEPES52894.2021.9699530

Graphene and its Nanocomposites based Microwave Non-Invasive Patch Applicators for Maximum Power Localization

Alka Singla
Assistant Professor, Electronics & Communication
SLIET Longowal
Sangrur
alka.singla274@gmail.com

Anupma Marwaha
Professor, Electronics & Communication
SLIET Longowal
Sangrur
marwaha_anupma@yahoo.co.in

Sanjay Marwaha
Professor, Electrical & Instrumentation
SLIET Longowal
Sangrur
marwaha_sanjay@yahoo.co.in

Abstract— **The design of a non-invasive patch applicator using graphene and its nanocomposites is proposed here to address the issues of localized power deposition in the target site, faster heat generation and specific penetration depth. The graphene material and its nanocomposites, such as graphene oxide (GO) and reduced graphene oxide (RGO) offer several benefits when employed as an absorber at microwave frequencies. The nanomaterial strip when placed on a side layer of the patch applicator controls the radiation pattern of the antenna hence providing significant improvement in directivity and reduction of sidelobe power levels. Initially, the graphene and its nanocomposites-based patch applicators have been designed and performance enhancement of hyperthermia treatment planning is validated from the plots of maximum power deposition and specific absorption rate (SAR). Further, it is demonstrated that RGO based microwave patch applicators outperform with a maximum power deposition and SAR value of 30.1 W/cm^3 and 113.4 W/Kg respectively. The realization of nanomaterial based patch applicator design in terms of faster heat generation is demonstrated by obtaining maximum temperature of 319°K in 10 minutes for RGO nanocomposite.**

Keywords—Graphene, Graphene oxide (GO) and Reduced Graphene oxide (RGO)

I. INTRODUCTION

Microwave non-invasive applicators are currently being employed in many therapeutic and diagnostic biomedical applications [1]. Their utility in treatment planning for microwave hyperthermia is the field of interest among researchers owing to the reduced risk of infection and minimized pain among patients. The crucial requirements for microwave hyperthermia treatment planning are optimal selectivity of the tumorous tissues for maximum energy deposition at the target, faster generation of heat, maneuverability, and penetration depth of microwave energies in tissues. Non-invasive applicators offer several advantages but there are still some persisting challenges in treatment planning that is the requirement to focus the microwave power at the target with a faster penetration rate at a particular penetration depth. Therefore, an accurate treatment planning for the optimal design of applicators having high directivity is needed.

Several investigations have been done so far to achieve this goal. To enhance microwave hyperthermia, the development of phased antenna array applicators has facilitated remarkable progress in obtaining larger ablation zones designs [2-4]. Moreover, the dielectric heating with parallel curve plate applicator based on electric fields generated for breast cancer treatment is proposed in [5]. Alternately, a temperature focusing technique based on the phased array applicator with an additional algorithm that optimized SAR focusing in neck phantom models [6]. Nguyen et al. [7] also proposed a particle swarm optimization technique to optimize the excitations for a 3-D antenna array to focus on a target. Another optimization technique based on Trust Region Framework optimization utilizing a 1×4 antenna array to accurately focus on target tissues is proposed in the research work [8]. Clinical trials using slot applicators have been presented in [9] for the evaluation of effective field strength and penetration depth. Thus, a large number of reported studies have adopted linear antenna arrays and circular antenna array configurations. As aforementioned cited literature studies, it is apparent that researchers are still focusing on the improvement of thermal focusing of power distribution. So far, little attention has been devoted to improving faster heat generation at specified penetration depth for more localization during the hyperthermia treatment.

Currently, cancer-related nanotechnology has also gained significant attention and exploited in many clinical studies. The author in [10] presented a review for the applications of micro nanomaterials to improve the efficacy of microwave hyperthermia treatment by receiving electromagnetic radiations. Further in [11] absorption properties of gold nanoparticles have been investigated proven to be effective in enhancing microwave hyperthermia treatment. From the recent works conducted by Maamoun et al. [12], silver and gold nanoparticles are proven to be very effective due to their absorption properties. Since these types of treatments include magnetic induced heating by taking advantage of absorbing electromagnetic waves at tumor region and least heating among surrounding healthy tissues. However, for consideration of other competing factors of producing heat in lesser time and effective penetration depth, the design of external electromagnetic applicators is complex and requires attention.

To deliver the energy in a conformal manner, the ability of the applicator depends on type and size, operating frequency, directivity and applied polarization field. Thus, for designing microwave hyperthermia system antenna configuration is a major concern since the penetration depth is frequency dependent that affects the depth of heating. Several beamforming techniques have also been exploited by controlling the excitations of antenna array elements for

2019 2nd International Conference on Intelligent Communication and Computational Techniques (ICCT)
Manipal University Jaipur, Sep 28-29, 2019

Wideband Graphene Absorber for Effective Sidelobe Suppression of Triangular Patch Antenna Array

*Surekha Rani, Anupma Marwaha, Sanjay Marwaha

Abstract: **An effective approach of integrating the microwave absorbing element with microwave radiating source is proposed in reported work to enhance the radiation pattern of radiating source. Microwave absorber in conjunction with patch antenna array produce a modified patch structure whose radiation patterns are better than conventional patch arrays in terms of array directivity, gain and levels of side lobe. Two element triangular patch antenna array has been reported in this work and from array gain and directivity plots it has been authenticated that radiation pattern of antenna array has been modified after integration of microwave absorber. Further the results of triangular array with absorber has been compared with rectangular array to ensure that the performance of triangular array is far better than rectangular array alongwith reduction in array size.**

Index Terms—absorption, reflection coefficient, antenna array, graphene

I. INTRODUCTION

Microwave absorbers have enormous applications in diverse fields such as it is used for eliminating electromagnetic pollution, which otherwise leads to chronic health diseases [1]. In defence area, absorbers are used in stealth technology for reduction of radar cross section [2]. To build an anechoic chamber, for laboratory testing of antennas, flooring, ceiling and side walls of a closed room is covered with microwave absorbing materials [3],[4]. In addition to all above applications, microwave absorbers are effectively used to reduce side lobe levels as well as increasing directivity of antenna array which otherwise will be obtained by complex computer aided codes [5].

With the advancement of integrated circuit technology, all the electronic gadgets are mobile in nature and therefore small and light weight. In this context, a transparent, light weight and small sized material proves a potential candidate for designing of microwave absorbers [7]. Some authors also propose metamaterial to serve above purpose effectively [8]. Epoxy resin loaded with graphene particles is the undisputable option which can satisfy absorber requirements.

Graphene when used as a filler material behaves in very unique manner i.e. when graphene particles are loaded in polymer matrix; it gives high conductivity as well as high dielectric loss without highly increasing impedance mismatch particularly at microwave frequency because graphene as filler offers high surface to volume ratio [9]-[11]. This property of graphene proves very advantageous while designing a light weight and transparent absorber which when integrated with antenna array, can effectively reduce its side lobe levels and enhanced directivity [16]. Reducing the sidelobe levels alongwith narrowing the array beamwidth is one of the major research topics so that signal can be efficiently transmitted from source to destination [5]. Therefore, researchers are concentrated on designing a large number of complex, computer programming based algorithms, so as to work array in high interfacing environment. Controlling the side lobe levels of array with computer programming is undoubtedly a good idea but it is very tedious and time-consuming task [6]. Same objectives can be fulfilled by applying absorber on antenna arrays which proves to be a good alternate to computer algorithm.

In this paper, two elements triangular patch array is designed. At the same time absorber resonating at the same frequency as that of array also designed. Microwave absorber is then integrating on both the arrays to check the effectiveness of the absorber on side lobe level and directivity of antenna arrays. Integrating the absorber with array makes a complex system, therefore, analytical solutions of Maxwell equations for solving such system becomes impractical, thus, numerical simulations are the indispensable requirement to verify theoretical results. Modelling and simulations of antenna array and absorbers are performed by finite element method (FEM) based commercial high frequency simulation software (HFSS).

II. ABSORBER GEOMETRY

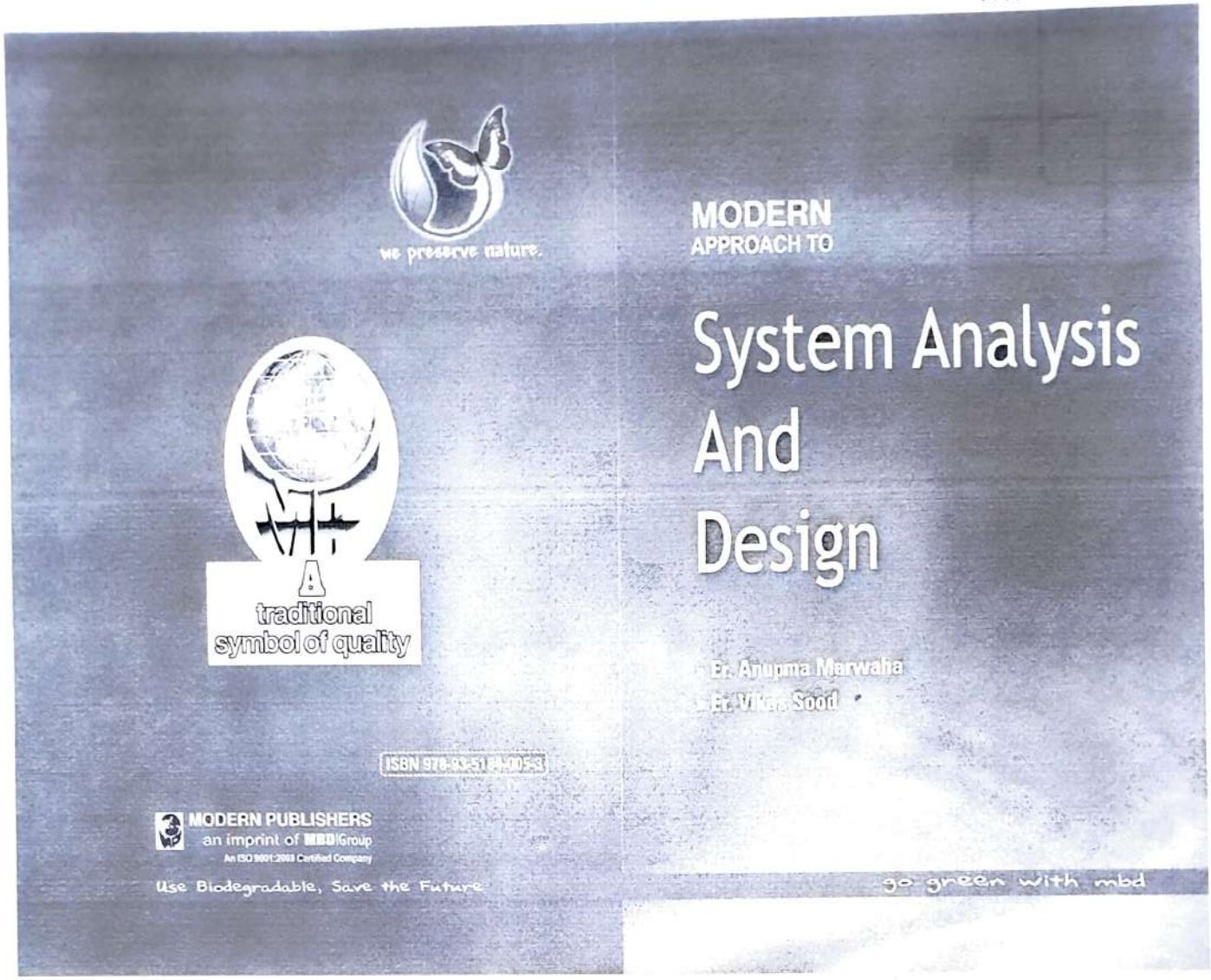
Proposed electromagnetic absorber is a composition of a layer of epoxy resin loaded with graphene particles of negligible thickness, followed by glass with 2 mm thickness, backed by perfect electric conductor (PEC). Epoxy resin loaded with graphene particles having relative permittivity of 20.4 works as good absorbing layer when particle size of graphene is 15 μm with 10 percent weight ratio. Dielectric loss tangent of absorbing layer is 0.18 at 10 GHz as measured by Kevin Rubrice et al. [12]. Fig. 1 displays HFSS simulative model of microwave absorber, with epoxy resin loaded with graphene particles as absorbing layer backed by glass layer that provides mechanical strength, and perfect electric conductor (PEC) layer that reflects the waves which manage to reach at the back side of the absorber. For proper excitation and absorption measurements, by inserting the absorber within a rectangular waveguide having two ports as can be seen in fig. 1.

Ms. Surekha Rani, Research Scholar, Electronics and Communication Engg. department, SLIET Logowal, Sangrur, India. (e-mail: surekhagarg9@gmail.com, Mob. No.: 9465233766)
Dr. Anupma Marwaha, Professor, Electronics and Communication Engg. department, SLIET Logowal, Sangrur, India. (e-mail: marwaha_anupma@yahoo.co.in
Dr. Sanjay Marwaha, Professor, Electrical and Instrumentation Engg. department, SLIET Logowal, Sangrur, India. (e-mail: marwaha_sanjay@yahoo.co.in)

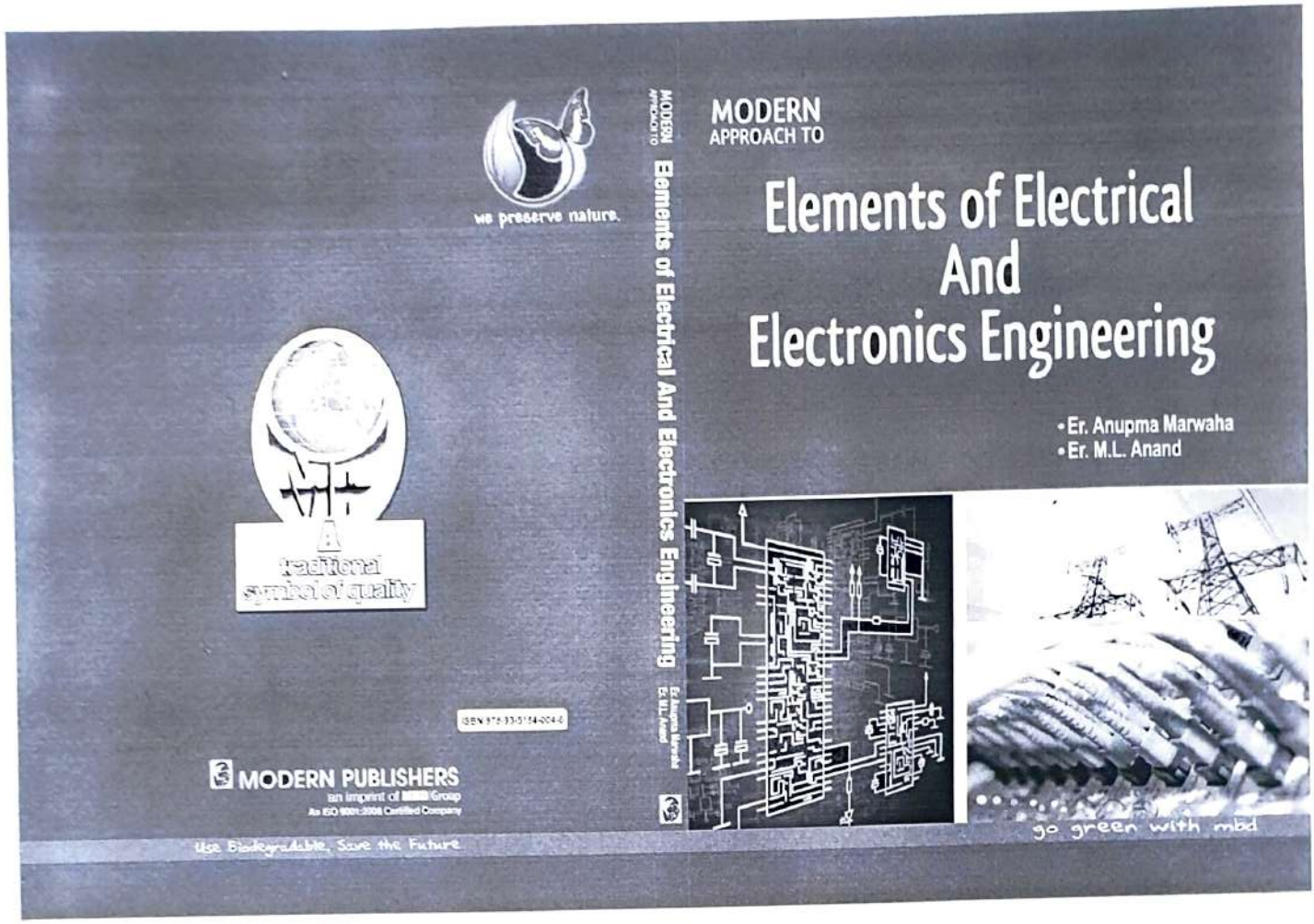
978-1-7281-1711-9/19/$31.00 ©2019 IEEE

Authorized licensed use limited to: University of Exeter. Downloaded on June 10,2020 at 11:09:23 UTC from IEEE Xplore. Restrictions apply

PAGES 130, 23x36x1



Pages 230 20x30x

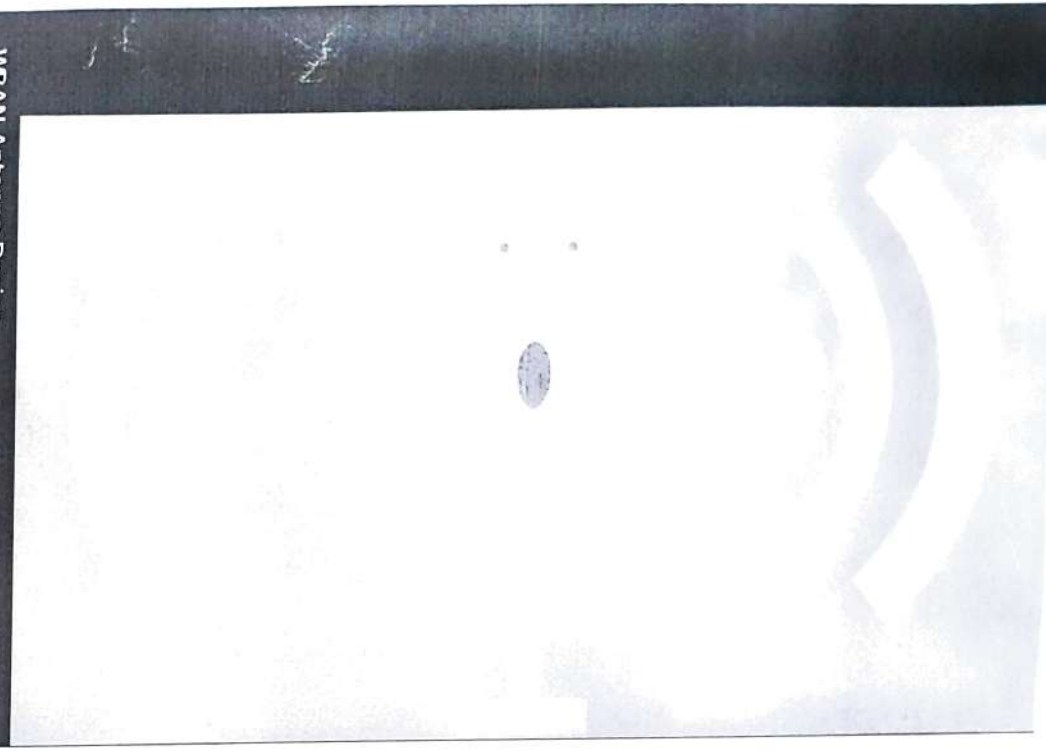


There are number of antennas required for a wireless body area network (WBAN) to perform different types of communications at different positions of body. Therefore to decrease the number of antennas, there is a need of antennas with flexibility of operation that is a single antenna should serves a purpose of more than one type of communication. In case of WBAN antenna is to be placed over body therefore shape of antenna should be adjustable according to the body. Most of the body parts are curved therefore flat antenna cannot follow the curvature of body and some of the part of antenna will be protruding, which can interfere the natural body movements. The curved shape antenna can follow the curvature of body therefore proposed antenna is made curved. The curved antenna discussed in this book is designed to be radiating at two frequencies 2.45 GHz and 5.8 GHz and modeling is done using CST software. The proposed antenna has less effect of radiations on body. The SAR value of antenna is 0.676 W/kg at 2.45 GHz and 0.294 W/kg at 5.8 GHz. These values of SAR are well below the limits for SAR in India.

Dr. (Mrs.) Anupma Marwaha is working as Professor(ECE)at SLIET Longowal,Distt. Sangrur,Punjab with 23 years teaching experience. She is a Fellow Member of ISTE, New Delhi and Institution of Engineers, India.She has more than 75 publications to her credit.Her research interests Bio-electromagnetics, Design of Microscale and Nanoscale EM Structures.

978-3-330-02518-9

WBAN Antenna Design



Anupma Marwaha
Rajdeep Singh

Antenna Design for Bio-Telemetry Applications

LAP LAMBERT Academic Publishing

Marwaha, Singh

2020 7th International Conference on Signal Processing and Integrated Networks (SPIN)

Reduction of specific absorption rate (SAR) for human head using circular patch antenna

Alka Singla
Electronics & Communication Engg.
SLIET Longowal
Sangrur, Punjab
alka.singla274@gmail.com

Anupma Marwaha
Electronics & Communication Engg.
SLIET Longowal
Sangrur, Punjab
marwaha_anupma@yahoo.co.in

Sanjay Marwaha
Electrical & Instrumentation Engg.
SLIET Longowal
Sangrur, Punjab
marwaha_sanjay@yahoo.co.in

***Abstract*— The aim of this paper is to analyze the effect of circular microstrip patch antenna over the human head and perform comparative study with the rectangular microstrip antenna by estimating specific absorption rate (SAR) and temperature distribution. Human head is the most sensitive area for radiations coming from the mobile phone. So the exposure of the biological life to the electromagnetic radiation (EM) should be within permissible limits as per the defined standards. Results show that the SAR value of circular patch applicator has been reduced to 0.15 W/kg and temperature distribution is lowered down to 0.9°C at a frequency of 835 MHz as compared to the values for rectangular microstrip patch antenna which are otherwise within specified limits. The numerical simulation has been performed using finite element based COMSOL Multiphysics software.**

Keywords*— *Specific absorption rate (SAR), Finite difference time domain (FDTD), Finite element mesh (FEM), Radio frequency fields (RF).

I. INTRODUCTION

In this modern era of communication, with the excessive usage of electronic equipment, the amount of radiation energy to which human bodies are exposed has also increased. In particular, electromagnetic waves in radio frequency zone (RF) are used in communication, cellular network and indoor wireless communication. These EM waves produces an adverse effect on biological life [1,2].

To avoid the effect of radiation on the human body many countries have provided guidelines and standards that specify safely levels in terms of specific absorption rate (SAR). SAR is the amount of radiation to be exposed by the human body [3], generally expressed in W/ Kg, it is either averaged over a whole body or localized at some body parts i.e. 1g or 10 g of tissue. According to the new IEEE standards, in the frequency range of 100 KHz to 3 GHz, the basic exposure for most parts of the body is 1.6 W/Kg SAR value. For the extremities (arms and legs distal from the elbows and knees, respectively, including the fingers, toes, hands, and feet), the basic restriction expressed in terms of SAR is 4 W/kg [4-6]. Continuous research has been done in order to establish safety in cellular mobile communication system for the interaction between human head and wireless communication device under various conditions. The quantitative evaluation of SAR and temperature distribution [7-9] using finite difference time domain analysis (FDTD) [10] and finite element mesh analysis (FEM) [11] is reported in literature.

The present work aims at designing circular patch antenna conforming to curvature of head for minimizing radiation effects. The phone models available previously used dipole antenna, helix antenna [12,13] and the recent advancements witnessed in the field of wireless communications has led to the use of compact and conformal microstrip patch antenna and planar inverted F-antenna (PIFA) for new phone models [14-16]. For reducing the effect of radiation in body, the main focus of the work is to design such an antenna which is more efficient for cylindrical tissues with SAR value and temperature distribution within the permissible limits. Earlier many shielding materials have also been used for reduction in SAR [17,18] but they however effect the performance of mobile phone owing to poor radiation efficiency. It is therefore suggested that circular patch antenna may be used which reportedly exhibits better performance than rectangular patch antenna. The interaction between the human head and antenna is solved by numerical simulation based on FEM analysis implemented using COMSOL Multiphysics 5.0

II. DESIGN METHODOLOGY

A. *Antenna Design*

Fig. 1 depicts the geometry of circular patch antenna on dielectric substrate which may be fabricated employing some sort of lithographic patterning on printed circuit boards. The mobile consists of a PCB where the antenna is mounted on the substrate, the material used here is FR-4 substrate with dielectric constant of 4.5. The antenna is modelled in spherical air domain of radius 200 mm with layer thickness of 50 mm. This spherical domain acts as a perfectly matched layer (PML) so as to absorb the outgoing radiations from the circular patch antenna. All domains except the PMLs are meshed by a tetrahedral mesh with maximum element size of five elements per wavelength so

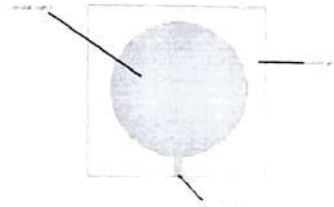


Fig. 1. Circular patch antenna.

XXX-X-XXXX-XXXX-X/XX/$XX.00 ©20XX IEEE
978-1-7281-5475-6/20/$31.00 ©2020 IEEE

Authorized licensed use limited to: Auckland University of Technology. Downloaded on May 26,2020 at 23:11:35 UTC from IEEE Xplore. Restrictions apply.

International Interdisciplinary Conference on Science Technology Engineering Management Pharmacy and Humanities Held on 22nd – 23rd April 2017, in Singapore ISBN: 9780998900001

A REVIEW OF NOVEL MATERIALS FOR NANOSCALE ANTENNA DESIGN FOR TERAHERTZ WIRELESS COMMUNICATIONS

Gaurav Bansal,
Faculty ECE Department,
NIT Hamirpur, H.P., India,

Anupma Marwaha,
Professor ECE Department,
SLIET Longowal, India ,

Amanpreet Singh
Deputy Controller of Examination
IKGPTU Jalandhar, India

Abstract—A critical review of novel nanomaterials is presented here to explore the feasibility of using nanomaterials for terahertz antennas to meet the challenges in ultra wideband applications. The THz band applications are limited within premises only and provide broadband wireless access to the internet at extremely small distances (upto few millimeters). Graphene is lately being identified as the nanomaterial used for design of microwave and terahertz devices. The use of graphene for antenna design in terahertz regime is being rigorously researched for enabling improvements in speed and efficiency hence providing higher data rates. The plasmonic nature of graphene conductivity at THz allows unprecedented antenna properties that may lead to efficient dynamic reconfiguration. The work here further suggests the development of design approach using graphene material for short range UWB nano-antenna for various wireless terahertz applications.

Keywords—Nanaomaterial; graphene; carbon nanotube; UWB; THz wireless communication.

Introduction

The Ultra wideband (UWB) electronic systems are finding increased use in terahertz (THz) wireless communication [1, 2]. The UWB systems provide extremely high data rates, high immunity to interference and noise, require little transmit power and provide much more flexible applications which could not be possible in megahertz (MHz) or gigahertz (GHz) range. The congested wireless communication bands in the MHz or GHz frequency range and the ever-increasing demand for more bandwidth, higher directivity have motivated the utilization of the unexplored spectrum of electromagnetic waves such as the THz region. The THz region corresponds to wavelengths in the range of 0.1 mm to ~1 mm (corresponding to the segment of the electromagnetic spectrum from 0.3 THz to 3 THz) in between the millimeter and far-infra (IR) waves [2]. The major challenge in UWB wireless system is the requirement of miniaturized antennas with broad bandwidth and minimum distortion of received and radiated pulses. The emerging applications in the field of terahertz communication systems demand for the development of miniaturized devices which would be capable of transmitting and receiving the data at low power, highest possible data rates, the ultra wide bandwidth and more directive.These days researchers are of the opinion that modern advances in novel materials for UWB nano-antennas can play a key role in THz wireless communications. The major challenges faced

Graphene Nanomaterial Based Terahertz Antenna Applications

Gaurav Bansal[1], Anupma Marwaha[2], Amanpreet Singh[3]
Department of (ECE)
Ph.D Research Scholar[1], Professor[2], Deputy Controller of Examination[3]*
IKGPTU Jalandhar, India[1, 3], SLIET Longowal, India[2]*
{Corresponding author's email: er.gauravbansal1988@gmail.com}

Abstract - Graphene nanomaterial based THz antennas which have the possibility to enable wireless communications at the nanoscale is hence foreseen to develop the capabilities of individual nanosystems both in terms of complexity and range of operation. The aim of this paper is to study miniaturized resonant THz antenna applications using novel nanomaterial, graphene as a patch conductor. The proposed techniques have been discuss to justify tunability, ultra wideband and higher directivity of graphene based nano-patch antenna along-with simplicity of THz antenna for different applications.

Keywords - Graphene: nano-patch antenna: ultra wideband: directivity: THz region.

INTRODUCTION

Recently, printed electronics is an interesting field of research which provides many advantages such as ease of fabrication, light weight etc. Under this category material based printed antennas are of great interest. Conventional patch antennas use copper or aluminum as the radiating patch. In this paper conventional copper radiating patch is replaced with graphene because of its extremely good electrical and thermal properties [1]. For graphene antenna printing applications, spraying is a less reported method, suffering from lacking of uniformity in films. Inkjet-printing and doctor blade methods are complementary, the former having high accuracy and cost, in contrast to the latter [2].

A. Potential Applications of Graphene

Motivated by the potentially outstanding properties of graphene serving as new performance frontiers, it is becoming a preferable alternative for designing a vast range of electronic devices, circuits and components. Several components such as frequency selective surfaces, waveguides, flexible super battery, mixer, transparent solar cells, filters and lenses have been reported. New types of composite materials based on graphene with great strength and low weight could also become interesting for use in satellites and aircraft. Within the past years, graphene field-effect transistors (GFET) have been successfully fabricated. In terms of operating speed, the results are impressive. GFETs have already achieved more than 160 GHz FET using conventional semiconductor manufacturing methods and even at 300 GHz have been explored, using however a non-reproducible GaN nano-wire based gate. Comparing graphene transistor operating speed to that of existing technologies (such as Si, III-V HEMTs, SiC, GaN, etc.) as discussed by [3] graphene based devices are already comparable to conventional technology state of the art. Most recently International Business Machines Corporation (IBM) researchers have built the world's most advanced fully functional integrated circuit (IC) made of wafer-scale graphene that has the potential to improve today's wireless devices for cheaper, high-speed communications. The creation of the first graphene IC, a broadband radio-frequency mixer, was reported by Lin et al. [4]. Graphene's high carrier mobility and saturation velocity make it a promising candidate for high-speed electronics and radio-frequency applications. Versatile graphene applications in electromagnetic design of nano-antennas have also been developed in recent years. The graphene material has given the platform for building flexible electronics with plethora of applications few of which are briefed as below.

B. Graphene Based Antennas

Dragoman M. (2010) depicted the use of graphene as substrate for metallic antennas and further the radiation pattern of the dipole array can be controlled by switching the high and low resistivity state of graphene via an external bias voltage [5]. Jornet J. M. et al. (2010) analyzed the properties of carbon nanotubes (CNTs) as potential for design of nano-dipole antennas in THz range. The transmission line properties of CNTs were obtained as function of CNT length, diameter and edge geometry. The antenna parameters were calculated and compared to those of a nano-patch antenna based on a graphene nanoribbon (GNR) with similar dimensions. The results showed that for maximum antenna size in orders of several hundred nanometers, both nano-dipole and nano-patch antenna will be able to radiate electromagnetic waves in the range from 0.1 to 10.0 THz [6]. Llatser I. et al. (2011) developed simple model of graphene based nano-antenna and analyzed the graphene patch to calculate absorption, scattering, and fading cross-sections for the free-standing patch. Fabry-Perot model has been used for fast estimation of the spectral position of graphene based antenna resonances. Numerical study of the graphene based nano-antenna has been presented for different antenna dimensions to investigate resonant properties with antenna dimensions of the order of few micrometers in the THz

A Brief Review on Bowtie Antenna

Baljinder Kaur, *Postgraduate Student*, Lakhvinder Singh Solanki, *Associate Professor*,
Department of Electronics and Communication Engineering,
SLIET Longowal-148106, Sangrur, Punjab, India

Abstract— ***The present paper deals with a brief review on different shapes of bowtie antenna used to improve its Performance including, better return loss, flatter input impedance, and more stable radiation pattern. It is not the intention of the author to provide a detailed survey on all the configurations. The main purpose of this paper is to provide a detailed survey on various approaches adopted especially, rounding, beveling, and creating different slot configurations on different parts of antenna.***

Index Terms— Bandwidth, Bowtie antenna, Return Loss, UWB antenna.

II. INTRODUCTION

Antennas are indispensable component of any wireless communication device. Thus they are the inevitable component for creating the so called "wireless human network". An antenna is a transducer between the transmitter and the free space waves and vice versa. They efficiently transfer electromagnetic energy from a transmission line into free space.

As the growing demand for wireless communications is constantly increasing, the need for better coverage, improved capacity and higher transmission quality rises. Thus, a more efficient use of the radio spectrum is required. Originally developed for Radar technology Ultra Wide Band has evolved to prove essential in the WPAN and WLAN market as a high speed networking solution for burst data [1]. UWB antennas are gaining widespread ,popularity because of their various superior qualities. According to the definition of the Federal Communications Commission, a UWB device has a fractional bandwidth that is greater than 0.2, or occupies 500 MHz or more of the frequency spectrum, regardless of the fractional bandwidth [2]. The release of an extremely wide spectrum for emerging commercial microwave UWB applications has greatly spurred the research and development of microwave ultra wideband (UWB) technology for communications, imaging, radar, and localization applications. Henceforth, many techniques to broaden the impedance bandwidth of small antennas and to optimize the characteristics of the broadband antennas have been widely investigated.

Desirable features of a wideband antenna are low-profile and wide bandwidth in a compact size. Many existing wideband antennas are large in size and some have only circular polarization. On the other hand low-profile, dual-polarized antennas frequently have limited bandwidth. The major UWB Antenna Design Challenges include Compact size while providing acceptable VSWR, Bandwidth, Gain, Efficiency, Omni-directional pattern, to be suitable for on chip design, with good impedance matching, light weight and low cost.

The ultra wide band antenna designs may be broadly divided as Travelling wave structures like Vivaldi antenna [3, 4], Frequency independent structures like the biconical antenna or the bowtie Antenna [5, 6], Self complementary antennas that are characterized by a self-complementary metallization like the logarithmic spiral antenna and fractal antennas [7-9], combinations of the above like the log periodic antenna [10-12] and the electrically small antennas which includes the modified monopoles [13-15]. New designs with frequency notch in the existing WLAN bands in the 5-6 GHz range have also been reported [16, 17].

Although existing designs offer excellent performance, many other considerations have become important. As broadband receivers came into common use, emphasis on inexpensive, easily manufacturable designs increased. The well-known "bow-tie" antenna originally proposed by Lodge and later re-examined by Brown and Woodward exemplifies these benefits [18].

A large volume of literature is available in journals and books explaining various Bowtie antennas. A brief recollection of the contributions by various eminent researchers to the field of antennas with related literatures is depicted here.

III. VARIOUS DESIGN CONFIGURATIONS OF BOWTIE ANTENNAS

While going through literature, there are various shapes of bowtie antenna which have been investigated for improved

Certificate

Department of Electronics and Communication Engineering
Motilal Nehru National Institute of Technology Allahabad
Prayagraj-211004, India

Springer

5th International Conference on VLSI, Communication and Signal Processing (VCAS 2022)

(October 14-16, 2022)

This is to certify that ***Mr. Ayushman Ramola*** *from* ***SLIET*** *has participated and presented paper titled* ***"An Exhaustive Review of Various Optical Devices for Biomedical Applications"*** *in 5th International Conference on VLSI, Communication and Signal Processing (VCAS 2022), Organized by Department of Electronics and Communication Engineering, Motilal Nehru National Institute of Technology Allahabad, held during October 14th-16th 2022 at MNNIT Allahabad, Prayagraj (U.P.), India.*

Prof. V.S. Tripathi

Prof. R. A. Mishra

Prof. R. K. Nagaria

An Exhaustive Review of Various Optical Devices for Biomedical Applications

Ayushman Ramola*; Surinder Singh, Anupma Marwaha
Dept. of Electronics and Communication Engineering
Sant Longowal Institute of Engineering and Technology (SLIET), Longowal, Punjab
*xlayushman@gmail.com

Abstract— **In today's world, optical sensors are designed for several applications, among which biomedical applications are a prominent investigation area. Optical sensors possess minimal size, small shape, high sensitivity, and low cost, due to which they are perfect for remote sensing applications. This review studies various optical devices manufactured and created for biomedical applications. These devices include "surface plasmon resonance (SPR)" based biosensors, "photonic crystal fiber (PCF)" based SPR biosensors, metasurface biosensors, thin film biosensors, vertical grading couplers, fiber Bragg grating-based biosensors, *etc.* All these biosensors aim to save patients' lives through early detection and prevent the disease from becoming fatal. The advantages and disadvantages of the various optical devices are also presented in this study. Thus this brief study suggests the possibilities of optical sensing through which various dangerous and harmful diseases can be identified.**

Keywords— Bragg grating; "photonic crystal fiber (PCF)"; "surface plasmon resonance (SPR)"; vertical grading couplers;

1. Introduction

Optical biosensors have the tremendous capability to detect various harmful and infectious diseases. These biosensors are based on several methodologies and can instantly see the presence of disease in the human body. According to the report published by "Global Market Insight," the medical biosensors global market is expected to rise to the USD of 42 billion by 2027. Today the need for biosensor devices is developing at a large scale. Several medical conditions, like diabetes, urine sample analysis, glucose concentration detection, *etc.,* have been investigated extensively through biosensors [1]. Researchers and scientists have proposed several medical biosensors based on refractometry, polarimetry, fluorescence, absorption, and surface plasmon resonance (SPR) conditions [2]. Some of the notable work done in the bio-sensing research area for medical applications is presented in these reviews. *Ratajczak et al.* [3] designed an optical biosensor to detect human cancer through hair tissue. In their work, they investigated the interaction between the "graphene oxide (GO)" with "survivin molecular beacon ($SurMB$)" having an advanced coating of the quencher Dabcyl and fluorescent Joe ($SurMB - Joe$). The proposed sensor presents a lower detection limit, $LOD = 16\ nM\ (S/N = 3)$ which is a complementary $tDNA$. *Zhou et al.* [4] presented a biosensor with a phosphorus coating on the biosensor surface. The designed sensor is created from the "photonics nano bio configuration." It has a LOD value of $1.0\ pg/mL$. It is having a ultra-sensitive configuration which is 100 times more sensitive than the GO and Au nanoparticles based biosensors. *Luo et al.* [5]

A study of Conventional Protocols applicable to the emerging IoT Systems and Devices

Jasvir Singh Kalsi
ECE Department
SLIET, Longowal
Sangrur, India
jasvirkalsi@sliet.ac.in

Jagpal Singh Ubhi
ECE Department
SLIET, Longowal
Sangrur, India
js_ubhi@yahoo.com

Abstract—**The era of development of intelligent machines has led to automation at such a level a combination of artificial intelligence and self-operating gadgets are over taking the manual operations. Further, the integration of such intelligence with Internet has extended the horizons of development and research to a new level and has led to development of Internet of Things (IoT) devices. Self-decision-making in-home appliances will make them smart appliances such as smart refrigerators, smart televisions, washing machines and dish washers, smart ACs, etc and are incorporated as "THINGS" in IoTs. Although this development is finding its way to new peaks but the protocols, methodologies and ethics of intercommunication of smart devices is still a work of art for researchers. This paper tends to provide an overview of various protocols of data transmission that are providing possible solutions to various problems that may be faced in secure data transmission, integration and manipulation of data for efficient decision making of smart machines and appliances placed remotely or locally. A comparison of various parameters such as operating frequency, range and data rate has been presented to analyze various technologies for various applications.**

Keywords— IoT Protocols, Smart machines, Constrained devices

I. INTRODUCTION

Internet of Things has extended its horizons over vast number of applications in recent years and still the detailing of its concepts and operations involved in it is an emerging field with numerous possibilities. The thought of interconnecting the devices so called "Things" over the newer or pre-existing internet link without much interference of human being has taken new step towards the intelligent appliances [1]. One of the most important challenge in this regard is the way or method of communication that may be used to communicate the data over the web i.e. protocol that the devices may follow. It is utmost important to generalize these rules and to be accepted worldwide. There are some technologies which have already taken their position while researchers are finding ways for others to be incorporated in IoT [2].

There is a lot of ongoing research to develop algorithms and protocols for IoT devices that must be light weighted so as to put minimum burden over the internet while transmission of data from sensors to decision making circuitry [3]. Although without any distinct boundary, many of these protocols can be classified as mentioned in Table I.

The emphasis of this study will be on an overview of Network Layer pre-defined Protocols and their applicability on IoT domain. The study will also cover the system architecture of two Application Layer protocols (CoAP and MQTT) that are recently used to implement efficient data communication between IoT devices.

TABLE I. LAYERED STACK OF PROTOCOLS [1][2]

Application Layer	Constrained Application Protocol (CoAP)
	Advanced Message Queuing Protocol (AMQP)
	Message Queuing Telemetry Transport (MQTT)
	Extensible Messaging and Presence Protocol (XMPP)
	Data Distribution Service (DDS)
Transport Layer	Transmission Control Protocol (TCP)
	User Datagram Protocol (UDP)
Internet Layer	Internet Protocol Version 4/6 (IPv4/IPv6)
	Routing Protocols
	6LoWPAN (Low-Power Wireless Personal Area Networks)
	Time slotted Channel Hopping (6TiSCH)
Network Layer	IEEE 802.15.1 (Bluetooth)
	IEEE 802.15.4 (LR-WPAN)
	IEEE 802.11 (Wi-Fi)
	IEEE 802.3 (Ethernet)
	IEEE 802.16 (WiMAX)
	IEEE 1901.2 (PLC)
	Long Range Radio Wide Area Network (LoRaWAN)

II. NETWORK LAYER PROTOCOLS

Although in addition to the enlisted protocols in the stack, there are many others that are used by researchers to find their optimum use in Internet of Things, yet the researchers are finding IEEE defined standards in Network Layer of Table I as more suitable for IoT applications because of their reliable architecture. These IEEE standards are summarised below with respect to their properties.

- *Bluetooth*

One of the versatile communication technologies used in IoTs for short range data transmission is Bluetooth and has found its applications in many consumer products and in house "Things". Even the wearable products such as smart wrist bands, smart rings, etc can be attached to smart phones through Bluetooth for transmission of sensor data. Keeping

Consequences of Body-Biasing Technique on SRAM Memory

Mukesh kumar, J.S. Ubhi

Abstract: *The circuit changes the threshold voltage effectively with a definite delay and power by altering the body biasing of the transistors. The body bias is employed to govern the frequency and leakage of the memory device. The threshold voltage of individual transistor is decreases by applying the reverse body bias (RBB) and increases with forward body bias (FBB). This paper presents the viability of RBB to decrease the leakage power and increase in the speed of operations for SRAM circuit. The investigation of RBB dependencies on various performance parameters are analyzed. It is observed that the leakage power improves by 30.32% on applying RBB voltage compared to zero body bias while the transient power increases by 3.22% but decrease of delay by 84.56% dominates on it. Because of this the overall energy consumption reduces by 84.06%. Further the simulation work is carried out to see effect of supply voltage variation on leakage power at different RBB voltage and temperature. Therefore, the RBB scheme is beneficial for devices of low leakage, low energy and high speed of operation but this RBB voltage is limited by band-to-band tunneling current.*

Index terms: *RBB, Frequency, leakage power, delay*

I. INTRODUCTION

Through persistent scaling in CMOS technology, the feature size of the incorporated circuits encounters numerous physical confinements. The increasing leakage current, and the number of transistor per unit area leads to power dissipation in the device. Numerous applications like analog to digital converter, cache memory of computer, laptop, high speed registers, electronic toys, biomedical and wireless sensor networks, need very low-power circuits for long-time performance [1, 2]. The power dissipation, stability and operating frequency are the main concern in semiconductor industry. The device performance deterioration is because of bias temperature instability (BTI), hot carrier injection (HCI), time-dependent dielectric breakdown (TDDB), etc. that causes irregular functioning, unsuitable biasing and inappropriate environment condition during their working [3]. The substrate or body of MOS devices in a design is common, therefore body of all often kept at same voltage. The body biasing technique is utilized to alter the threshold voltage of transistors. As the source to body bias voltage increases, the depletion width of channel-body increases resulting in enhanced trapped charge density in depletion region and to maintain neutrality in channel charge must decrease. It impacts on the gate channel potential drop by adding of body bias to the channel-body junction voltage [4]. Various schemes have been implemented to apply body biasing on the transistors to decrease the delay (by reducing threshold voltage), the active power (on bringing down supply as well as threshold voltages although keeping up a similar speed when compared with a high threshold voltage circuit), leakage current or intra-die as well as inter-die threshold voltage disparity (by adaptive biasing) [5, 6]. The power and current requirement of body bias generator may get important, if the body bias voltage of transistors of a circuit is adjusted [7]. There may be two types of body biasing implemented: FBB is used to reduce threshold voltage and enhance device performance while RBB is utilized to enhance the threshold voltage and reduce the leakage current and hence power [8]. The use of the FBB is to boost threshold voltage roll-off conduct empowers the utilization of shorter gates can be clarified by a quasi 2-Dimensional model. RBB technique is often used to reduce the leakage of the circuit especially when it becomes idle. Reverse body biasing leads to increase in threshold voltage and hence decreasing the subthreshold leakage current. However, band to band tunneling current from source to substrate and drain to substrate p-n junction diode increases with increase of reverse bias voltage [9]. It is approaching to reduced leakage current at high value of reverse bias voltage. Consequently, an optimum RBB voltage is restricted by increased band-to-band tunneling currents that can be used in a transistor to decrease the total leakage current [10]. The efficacy of RBB is diminished as scaling of technology occurs because of increased effect of short channel and reduced impact of body effect [5], [9]. It is assumed that forward body biasing approach may be an alternate to the reverse biasing. It not only increases the body effect but also reduces the short channel effect. It is supposed that forward body biasing will be more productive in managing the threshold voltage of MOS device in near future technology as the ratio of supply voltage to threshold voltage reduces with scaling of technology [7]. The reverse body biasing voltage of a MOS transistor is limited by the voltage applied across the gate oxide. It can also be decreased by scaling down the gate oxide thickness in future generation of technology [11]. The remaining of the paper is structured as the following: In section II, the proposed SRAM cell structure is described. Section III shows the simulation results of the performance parameters by applying the body biasing of the SRAM cell. Finally, Section IV includes the conclusion and at last references are included.

Revised Manuscript Received on August 10, 2019.
Mukesh Kumar, Department of ECE, Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, India.
Corresponding author: mukeshrai131985@gmail.com
Dr. J. S. Ubhi, Department of ECE, Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, India.

Comparative Analysis of Standard 9T SRAM with the Proposed Low-Power 9T SRAM

Balraj Singh, Mukesh Kumar and Jagpal Singh Ubhi

Abstract This paper presents a novel 9T SRAM (static random-access memory) cell design with reduced leakage power and high performance. The design makes use of a sleep transistor so as to curtail the leakage power by eliminating the formation of a direct connection between the supply voltage (V_{DD}) and ground. The results are compared with existing 9T SRAM cell with the same transistor sizing and parameter variations. The designed SRAM cell has decoupled read and write operations and is simulated using Cadence at 45 nm CMOS technology. At 0.8 V, the proposed cell has an improvement of 31.78% and 73.66% respectively in dynamic and static powers when compared with the reported 9T SRAM cell. Also, nearly 36% improvement in power delay product (PDP) is achieved with the proposed design.

Keywords SRAM · Leakage power dissipation · Dynamic power · Static power Transistor sizing · PDP

1 Introduction

In earlier times, the major challenges for the VLSI designer were area, performance, cost, and power consumption. In recent years, however, power consumption is being given comparable weight to area and speed considerations. With the technological developments, Moore's law has led to a much smaller integrated circuit technology. Amid the shrinking of the technology, the performance of the integrated circuits is enhanced but this improved performance comes with the cost of increases in leakage power, process variation, and power density. Today, most of the power systems

B. Singh · M. Kumar (✉) · J. Singh Ubhi
Department of ECE, SLIET, Longowal, India
e-mail: mukeshkumar@sliet.ac.in

B. Singh
e-mail: balraj@gmail.com

J. Singh Ubhi
e-mail: js_uhbi@yahoo.com

© Springer Nature Singapore Pte Ltd. 2019
B. S. Rawat et al. (eds.), *Advances in Signal Processing and Communication*, Lecture Notes in Electrical Engineering 526,
https://doi.org/10.1007/978-981-13-2553-3_52

Low Power 3-Bit Flash ADC Design with Leakage Power Reduction at 45 nm Technology

Jagpal Singh Ubhi , Akash Tomar, and MukeshKumar
Department of Electronics & Communication Engg.
SLIET, Longowal
Sangrur, India
js_ubhi@yahoo.com; akash.tomar.bit@gmail.com; mukeshrai131985@gmail.com

***Abstract*—Most of the signals encountered in real world are analog in nature. Analog-to-digital converters are needed for conversion of an analog signal into digital signal. These converters can be implemented by using different available architectures. The performance of a converter is mainly analyzed based on its speed, area and power. Selection of a particular architecture totally depends upon its application. In this paper, the focus is on dynamic power, static power and delay of an ADC. Threshold Modified Comparator Circuit (TMCC) is used to reduce power dissipation. The work includes use of Self Controllable Voltage Level (SVL) technique to design a flash ADC for reduction of the leakage power. The simulation results of such ADC have been compared at 180 nm and at 45 nm technology. The proposed ADC has 41.12 µW dynamic power dissipation at 10 MHz frequency and 2.12 nW static power dissipation for 1.8 V at 45nm technology node. This data gets reduced to 1.866 µW dynamic power dissipation at the same frequency and static power gets reduced to 119.3 pW for 1.1V at 45nm. The software used for the designing and analysis purpose is Cadence Virtuoso version IC6.1.5.500.14.**

***Keywords*—ADC; TMCC; SVL; comparator; dynamic power dissipation; static power dissipation**

I. INTRODUCTION

Analog to digital converters are an essential part of electronic system design. These converters cover a wide range of application like music recording, digital signal processing (in TV tuners), scientific instruments (radar) etc. There are different types of architecture available of ADCs, each with their own benefits and limitations and specific applications. Various architectures such as Flash type ADC, pipelined convertor, Sigma Delta convertor, successive approximation convertor, folding ADC are used to design a converter. Flash type ADC have several advantages, it is very simple to operate and is the fastest ADC architecture among all architectures. It has of a number of comparators connected in series and an encoder circuitry. Comparators are connected with a resistor ladder; each comparator compares the input signal to a unique reference voltage as shown in Fig.1.

The outputs from the comparators are connected to the inputs of a priority encoder circuit. Sometimes comparator's output is in thermometer code, in that case a thermometer to binary encoder is used in place of priority encoder. The function of priority encoder is to generate a binary number

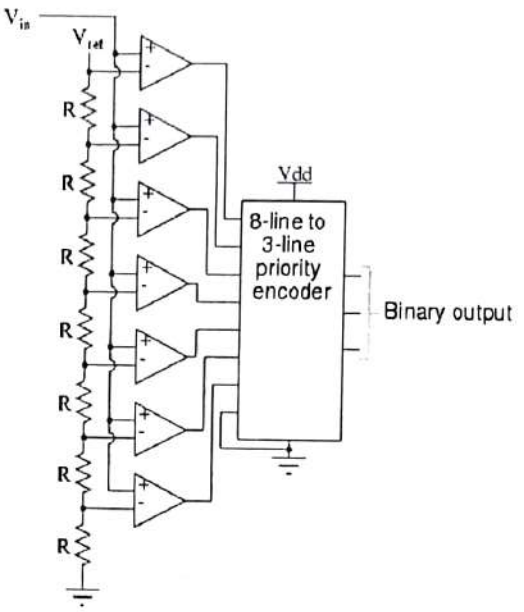


Fig. 1. Flash ADC Architecture [1].

which is based on the highest-order active input and it ignores all other active inputs and hence analog data converts in digitized form.

The power dissipation has now become an important issue for general purpose and high-performance processors because of the emphasis for processor are "Performance-per-watt". The total power dissipation is given by [9]

$$P_{total} = P_{static} + P_{dynamic} + P_{sc} \quad (1)$$

The power dissipation during switching transitions for charging and discharging parasitic capacitances or from OFF to ON state of a transistor or vice versa, is the dynamic power dissipation and is mathematically expressed as:

$$P_{dynamic} = \alpha C_{total} V_{DD}^2 f \quad (2)$$

The short circuit power is the amount of power dissipation during the conduction of both NMOS and PMOS

978-1-5386-3782-1/18/$31.00 ©2018 IEEE

Performance Evaluation of 6T, 7T & 8T SRAM at 180 nm Technology

[1] Mukesh Kumar
mukeshrai131985@gmail.com

[2]Jagpal Singh Ubhi
js_ubhi@yahoo.com

[1,2] SLIET, Longowal, Punjab

Abstract: **The high-speed system and shrinkage in technology lead to more complexity with higher power dissipation. This paper presents the design, simulation and analysis of 6T, 7T and 8T SRAM cells. The analysis has been done for dynamic power, static power, rise time, fall time, delay, and bandwidth measurements for SRAM cells at gdpk180 technology. The Cadence Virtuoso tool is used for drawing schematic, layout editing, design rule checking (DRC), layout versus schematic (LVS) to check whether layout matches the schematic and RCX. An attempt is also made to find out delay, static power, and dynamic power at different supply voltages. Results illustrate the static power dissipation is almost same for all the SRAM cells whereas dynamic power has the least value of 5.45 µw for 7T SRAM cell and 10.26 µw, the most for 8T SRAM cell. All the simulation results are carried out at fixed 27°C temperature.**

Keywords: SRAM, DRC, LVS, RCX, Delay, Rise time, Fall time, Power dissipation.

I. INTRODUCTION

It is very challenging to design electronic gadgets with very efficient working and consume the least power. Major issues that persuade the necessity of low power design are the increase of different kind of electronic gadgets viz. smart card, audio video supported multimedia products, wireless device etc. These devices and systems need high density, high speed and low power design [1]. SRAM plays an important role in cache memory of computer, laptop, analog to digital converter, high speed registers, electronic toys, mobile phone, camera etc. The SRAM is advantageous as it does not require refreshing data until the power is ON. The maximum attainable data storage capacity of a memory chip approximately doubles in every two years [2]. Consistent scaling leads to the need of very high density, high performance, low leakage current, less power dissipation with low cost.

An attempt to analyze the performance of NAND and NOR gate based on CMOS technology is done. Result shows NAND gate dissipates 55.73% lesser static power, less area and less access time [3]. A 6T SRAM has been designed for low power application in 180 nm and 90 nm technologies. It is observed as scaling down occurs the dynamic power, current, rise time, fall time and area reduces [4]. It is found that leakage of a transistor is responsible for more than 40% of power dissipation occurs in the circuit. Various power reduction techniques like Self-Voltage Controller circuit, Transistor Stacking, and Supply Voltage Reduction, have been implemented. It has been observed that as voltage increases, the proportionate increase in leakage current occurs [5]. A 16 Kbit memory has been designed that operates at the frequency of 1.24 GHz. For cell arrays, sleep controller and power cut-off during standby mode for low leakage current are used. Programmable timing control circuit is used to mitigate the delay variation [6]. It also focused on energy analysis of SRAM with multi-threshold to reduce power dissipation and improve performance. For reducing leakage current high threshold is required for cross coupled latch and access transistor. With optimum device combination energy efficiency improved by 6.24 times whereas, optimum device combination along with performance boosting and power reduction technique shows 33 times improvement of energy efficiency [7]. Transistor sizing has the very crucial role for a read or write operation to be stable [8]. Dual threshold 7T SRAM cell is proposed and compared with the standard 6T SRAM cell. It analyses the basis of read delay, write delay, leakage power consumption and Static Noise Margin in all the three (hold, read and write) mode of operation. Single bit line is used to reduce the access time for read and write operation. The leakage power consumption and write delay are reduced by 61.50% and 66.67% respectively [9].

The detailed analysis of 6T, 7T, and 8T SRAM cell with respect to various electrical parameters is carried out. It observes the variation of dynamic power, static power dissipation and delay with supply voltage. Also an effort has been made to analyse the variation of temperature on dynamic and static power dissipation. Full custom layout design has been done successfully for the said SRAM cells and RCX completed successfully.

This paper has been organized into following steps: Section I enlists a brief introduction of previous work done. Section II has a discussion on the operation of various schematic of SRAM cells. Section III shows the Layout and its Av-Extracted view that may be used for post layout simulation. In Section IV simulated results are discussed

International Journal of Electronics, Electrical and Computational System
IJEECS
ISSN 2348-117X
Volume 6, Issue 4
April 2017

Academic Science

Analysis of CMOS based NAND and NOR Gates at 45 nm Technology

[1]Balraj Singh [2]Mukesh Kumar [3]J. S. Ubhi
[1, 2, 3]Department of ECE, SLIET, Longowal, India

Abstract- *There are various basic gates like inverter, NAND gate, NOR gate which are extensively used in the designing of the more complex circuits with higher number of transistors such as SRAM cells, MUXs, ADCs and various other circuits. In this paper, we have carried out the modeling of NAND gate and NOR gate at 45 nm technology. The modeling includes schematics design, layout design and layout vs schematic (LVS) run of the above gates. Also the simulation results of both the gates are obtained at the same node with rise time, fall time, area, delay and power dissipation (dynamic power and static power). The results neither obtained show that NAND gate is advantageous in every aspect considered to that of NOR gate. All the processes have been carried out using the Cadence Virtuoso tool.*

Keywords- NAND gate, NOR gate, modeling

I. Introduction

The technological advancements leading to the shrinking of VLSI technology has to follow the various perspectives such as a decrease in the power dissipation, higher signal to noise margin (SNM), lower area, higher speed and lower cost etc [1]. As the technology is scaled down from higher node to lower node, these various aspects change accordingly. So depending upon the application and fabrication availability we use a particular node. Static CMOS are very power efficient as they dissipate nearly zero power while in idle state. These are frequently used for modeling of various designs. Taking into consideration of the history of CMOS design, power was secondary consideration after speed and area for many chips [2], [3]. But as the transistor counts and frequencies have increased, power consumption has shoot up rapidly and hence now is a primary design constraint [3]. Sub-threshold leakage power is already a major problem for battery powered designs in 45 nm node and will increase exponentially as power supplies and threshold voltages are scaled down further. Most of the power systems need higher performance when in active state and lower leakage when in idle state [4].

This paper is organized into four sections. Section I provides general introduction about the low power designing and scaling effects. Section II illustrates the CMOS NOR schematic design with its transient response and layout design while the section also derives the various parameters of the NOR gate in the 45 nm technology. In section III, there is schematic design of CMOS NAND gate with its transient response and layout design. This section also includes the various results obtained in designing of NAND gate at 45nm node. Finally, section IV concludes the paper.

II. Design of CMOS NOR gate

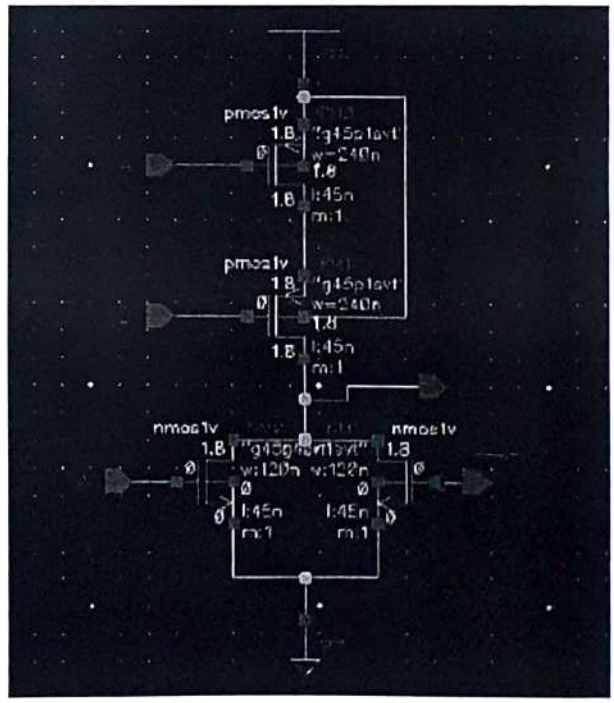


Figure 1: Schematic of CMOS NOR gate

A Multi-track National Conference
SLIETCON–2019
(March 1 - 2, 2019)
Sant Longowal Institute of Engineering and Technology, Longowal

RF Energy Harvesting: An Approach Towards Green Technology

Rajdevinder Kaur Sidhu[1], Jagpal Singh Ubhi[2], Alpana Agarwal[3]

[1]Research Scholar (ECE) & SLIET Longowal, [2]Professor (ECE) & SLIET Longowal,
[3]Associate Professor (ECE) & TIET Patiala

[1]rajsidhu_33@yahoo.com, [2]js_ubhi@yahoo.com, [3]alpana@thapar.edu

Abstract

The evolution in energy harvesting captures much attention in this modern world. Various energy-harvesting topologies like solar, vibrational, piezoelectric, RF (Radio Frequency) etc. are available but the RF energy harvesting esteems a bright future in generating a little amount of electric power that drives various low power electronics devices due to its easy availability and self-sustainability. This paper presents the basic overview of RF energy harvesting system that how RF energy is being converted into electrical power using various circuits and topologies.

Keywords: Antenna, Energy harvesting, Impedance, Rectifier, RF, Super capacitors.

Introduction

In today's world, energy and environment, both becomes a matter of concern among the researchers over worldwide. As the environment serves a good amount of energy in various forms like sun, wind, and electromagnetic radiations, it is preferable to utilize that energy in one way or the other. Energy harvesting or one can say energy scavenging is one alternate to use the freely available energy in the environment [1]. The typical energy harvesting system extracts, assembles and stores the energy in order to convert it into useable electrical energy. There are numerous ways to harvest the energy from the environment including solar, thermal, radio frequency, mechanical and so on. Table 1 summarizes the brief difference between the various types of energy harvesting techniques. Out of all, radio frequency energy harvesting technique is most popular due to its abundance availability [2].

TABLE 1: Different Types of Energy Harvesting:

HARVESTING TECHNIQUE	ENERGY SOURCE	HARVESTING DEVICE	HARVESTED POWER
LIGHT	Sun	Solar cell	100μW-100mW
THERMAL	Heat	Thermoelectric generator	60μW-10mW
VIBRATIONAL	Stress	Piezoelectric film	4μW-800μW
RADIO FREQUENCY	Radio Signals	Rectenna	0.001μW-0.1μW

This paper aims to give the overview of the RF energy harvesting system, which helps in designing the RF energy-harvesting model that delivers the power supply to various other low power electronic devices.

RF energy harvesting system

Radio Frequency (RF) energy harvesting is the phenomenon of capturing the excess amount of energy from transmitted communication signals, converting it onto a usable electrical energy and then utilizes it in any form [3].

The architecture of Radio Frequency energy harvesting system includes of RF energy source, receiving antenna, matching network, RF rectifier and output storage unit as shown in Figure 1, where the electromagnetic RF waves are grabbed with the of receiving antenna, output impedance of antenna is matched input

CHAPTER 2

RF Energy-based Smart Harvesting Systems

Rajdevinder K. Sidhu[1,*], Jagpal S. Ubhi[1] and Alpana Agarwal[2]

[1] *Sant Longowal Institute of Engineering and Technology, Longowal, Punjab, India*

[2] *Thapar Institute of Engineering and Technology, Patiala, Punjab, India*

Abstract: Energy and the environment have both become a matter of concern among researchers worldwide. There are several forms of energy present in the environment; therefore, utilizing these resources is preferred. In the modern world, the evolution of energy harvesting has received a lot of attention. Various energy harvesting topologies like solar, vibrational, piezoelectric, RF (radio frequency), *etc.*, are available, but RF energy harvesting has a bright future in generating a small amount of electric power that drives various power-constrained electronic devices due to its easy availability and self-sustainability. The circuitry, which converts RF energy into DC output, is termed the rectenna unit of the model. The rectenna unit consists of receiving antenna followed by the matching network and rectifier. The aim of this chapter is to provide a detailed review of various technical aspects of radio frequency energy harvesting, which have been showing a great proliferation in the designing of the RF energy harvesting model. Comparative analysis of different topologies of each aspect is also performed.

Keywords: Antenna, Energy Harvesting, Impedance, Matching-network, MOSFET, Radio frequency, Rectenna, Rectifier, Threshold, Voltage-Compensation.

INTRODUCTION

The atmosphere around us has an abundance of natural energy, such as solar or wind energy; this energy may be radiated into the surroundings by human beings for their use in the form of low-power electromagnetic radiations. The majority of man-made radiations are used for achieving high performance, sustained, effective, and efficient communication, which mostly include wireless data transmission in the form of electromagnetic radiations, with enhancement in technology and an increase in the use of hand-held wireless devices [1]. Technological growth in mobile phones fused with recent trends in the internet of things, and their uses for various applications starting from simple monitoring to

* **Corresponding author Rajdevinder K. Sidhu**: Sant Longowal Institute of Engineering and Technology, Longowal, Punjab, India; E-mail: rajsidhu_33@yahoo.com

Akhil Jabbar Meerja, Mamun Bin Ibne Reaz and Ana Maria Madureira (Eds.)
All rights reserved-© 2022 Bentham Science Publishers

A Survey Study of Different RF Energy Sources for RF Energy Harvesting

Rajdevinder Kaur Sidhu
ECE Department
SLIET, Longowal
Sangrur, India
rajsidhu_33@yahoo.com

Jagpal Singh Ubhi
ECE Department
SLIET, Longowal
Sangrur, India
js_ubhi@yahoo.com

Alpana Aggarwal
ECE Department
TIET, Patiala
Patiala, India
alpana@thapar.edu

***Abstract*—Radio Frequency (RF) energy conversion and harvesting topologies gains much attention that promises to operate the low power devices. The base of any RF energy harvesting model is the selection of appropriate RF souce followed by other three main stages which include receiving antenna, converting into DC output and utilisation of that output in any low-power applications. In this context, we present an extensive survey on the various RF sources (DTV, GSM, Wi-Fi) available in the frequency range of 3KHz -3GHz. This paper aims to review the progress of ambient sources which is expected to be useful in designing the RF energy harvesting model.**

Keywords—Energy Harvesting, Power Density, Radio Frequency, Rectenna, RF source.

I. INTRODUCTION

The sources that emit radio frequencies are billions in number all around the world. These sources include very small appliances such as cell phones and hand held devices, and the gigantic setups such as a radio base station, mobile base station[1]. Most of the RF energy that is transmitted by these sources is transmitted omni-directionally irrespective of the coordinate position of receiver. Hence there is a lot of RF energy that is wasted away due to non reception by any device. This provides an idea of harvesting the excess of RF energy from the ambience that may be used for low power hungry wireless charging devices which may enhance the usability and reliability of that device[2].

The uses may further be extended to battery operated components and devices as it may provide extended life time of operation without replacement of batteries. Moreover, the devices that consume very less power can be designed to operate on the harvested energy itself and the batteries can be omitted. One of a major advantage is that the RF energy received continuously due to a very large number of radio frequency band energy transmitters. A large number of the devices can be thought of such as Mobile phones, that have crossed a mark of 6 billion worldwide, wifi systems and routers, laptops, Television/ Radio/ Mobile base stations, Satellite geo-transmission[3]. In case of urban environment, it can be seen that there is a possibility of many wifi routers at a single place or placed in the vicinity of each other. Each router may emit 50-100 mW in all directions although this emitted power is not fully utilized[4].

Most of the devices operate in unlicensed bands (5.8GHz, 2.4GHz, 915MHz and 868MHz). The traditional cellular communication systems had 3.6W as maximum transmitted power. Nowdays, the EIRP (Effective Isotropic Radiated Power) at 915 MHz frequency band is limited to 4W by the authorities. The similar case is with RFID (Radio Frequency Identification) based interrogation and detection systems[2][3].

This paper aims to review the progress of ambient sources which is expected to be useful in designing the RF energy harvesting model. Section II provides the basic information about the rectenna unit of RF energy harvesting system that converts the RF signal into the DC output. Various RF energy sources are discussed in section III of this context which involves DTV, GSM, Wi-Fi sources.

II. OVERVIEW OF RECTENNA CIRCUIT

The system designed for harvesting RF energy must have an additional antenna for receiving energy to be rectified and converted into dc voltage with help of intermediate circuit apart from reception antenna. The main antenna may be tuned to a particular frequency as per circuitry requirements whereas a secondary antenna must have capacity to receive whole radio frequency band to ensure the maximum reception of free power from ambience. The antenna deployed for the operation is nomenclatured as "Rectenna". Practically, this is part of original antenna deployed for communication. This could be a monopole or microstrip patch type or even PCB based antenna selected as per the requirement of main circuit operations without disturbing it[5]. Mostly, the rectifying circuit has any of the non linear operating devices such as Impact ionization Avalanche Transit-Time diode (IMPATT) & Schottky Diodes and MOSFETs. The researchers are finding various solutions in Complementary MOSFET (CMOS) technology to design circuits that are capable of rectifying the 3KHz to 3GHz spectrum.

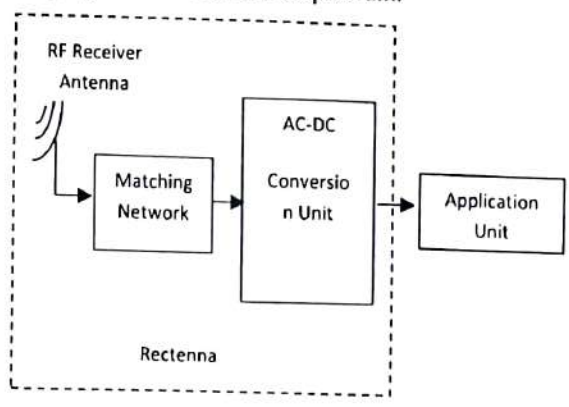


Fig. 1. Block diagram of RF Energy Harvesting Model

978-1-5386-8010-0/19/$31.00 ©2019 IEEE

CMOS Rectifier Topologies for RF Energy Harvesting: A Review

Rajdevinder Kaur Sidhu, J S Ubhi

Department of Electronics and Communication Engineering, Sant Longowal Institute of Engineering and Technology, Longowal, Punjab

✉ *rajsidhu_33@yahoo.com*

✉ *js_ubhi@yahoo.com*

Alpana Agarwal

Department of Electronics and Communication Engineering, Thapar Institute of Engineering and Technology, Patiala, Punjab

✉ *alpana@thapar.edu*

ABSTRACT

The advancement of energy harvesting topology gained much attention in this modern world. RF energy harvesting esteems a bright future in generating a little amount of electrical power to drive various low power electronics devices due to its easy availability. This paper presents various topologies of rectifier circuit used to convert RF signal into useable electrical power. The circuit topologies are simulated in ADS Tool with 45 nm CMOS technology. Various threshold compensated topologies of rectifier circuit are also discussed with the aim of getting efficient output to operate different low power devices.

Keywords : CMOS; Energy harvesting; Radio frequency; Rectifier; Threshold

INTRODUCTION

In today's era, energy harvesting is gaining a lot of attention and holds a bright future for producing the electric power. The energy harvesting system extracts, assembles and stores the energy as usable electrical power. There are numerous ways to harvest the energy from the environment including solar, wind, thermal, radio frequency, and so on[1]. Out of all, Radio Frequency(RF) energy harvesting technique is the most popular due to its abundance availability and approach towards the green technology. This harvests the power from RF signals that can be found everywhere from rural areas to highly urbanized area irrespective of day and night[2].

Radio Frequency energy or simply RF source, is easily available in all the major surrounding areas, these signals are known as ambient RF. This energy is virtually available in many forms (Wi-Fi signal, towers etc.), all the times irrespective of the day-night and environmental conditions[3]. The little amount of energy available for harvesting is neither constant nor easily predictable. As such, it must be ensuring that any harvesting design remains useful over a wide dynamic range of available input power. Nonetheless, this form of ambient energy remains the most promising for use in consumer-oriented portable electronic devices, due to theoretical 24 hours availability, lack of required physical effort to charge and quasi-independent from weather conditions.

Typically, RF energy harvesting system consists

Analysis of Ambient Sources for RF Energy Harvesting

Rajdevinder Kaur Sidhu, J S Ubhi

Department of Electronics and Telecommunication Engineering, Sant Longowal Institute of Engineering and Technology, Longowal, Punjab

✉ *rajsidhu_33@yahoo.com*

✉ *js_ubhi@yahoo.com*

Alpana Agarwal

Department of Electronics and Telecommunication Engineering, Thapar Institute of Engineering and Technology, Patiala, Punjab

✉ *alpana@thapar.edu*

ABSTRACT

The evolution in energy harvesting captures much attention in this modern era. Various energy-harvesting topologies like solar, vibrational, piezoelectric, RF (Radio Frequency) etc. are available but the RF energy harvesting esteems a bright future in generating a little amount of electric power that drives various low power electronics devices due to its easy availability and self-sustainability. The basic fundamental requirement in designing the efficient RF energy harvesting model is to choose the most convenient RF energy source followed by another three main levels that involves receiving antenna, matching circuitry and RF rectifier for the conversion of RF signal to DC power. In this article, sizeable survey on various RF ambient sources (DTV, GSM, Wi-Fi) with frequency ranges from 3kHz -3GHz is introduced. The paper presents the output voltage corresponding to different captured sources on ADS platform. The main aim of this context is to analysis various ambient sources acceptable in the designing of RF energy harvesting model.

Keywords : Energy harvesting, Rectenna, Rectifier, RF source

INTRODUCTION

Energy is the basic necessity for sustaining human life, which affects each and every one of our activities. In the very early days, human used muscle power to drive the simple implements and machines, which could only run for a limited time and had constraints on their continuous availability[1]. The biggest alteration happened when we learnt to generate energy, by transforming one state of energy, possibly latent, to another. Suddenly, vast possibilities opened up where energy could be obtained, transferred and stored for future use. The procedure of converting the available raw energy into beneficial electrical energy, termed as energy harvesting. Basically, the term energy harvesting is one of the primal methods for the conversion of solar energy into electrical energy. Afterwards, this approach has been extended to various other energy sources like RF energy, mechanical energy, piezoelectric energy, and thermal energy[2]. Out of all the energy sources, RF energy sources are freely available irrespective of the environmental conditions. Also, the availability of RF energy is

Chapter 11
The Role of Infrared Thermal Imaging in Road Patrolling Using Unmanned Aerial Vehicles

Neha Sharma, A. S. Arora, Ajay Pal Singh, and Jaspreet Singh

Abstract In the past few years, the tremendous growth in road network and vehicles has increased the road fatalities at a very alarming rate. Road patrolling is one of the prominent measures to reduce road fatalities. Generally, road patrolling has been done using manned ground vehicles whose performance is highly dependent on environmental conditions. With this in mind, an infrared (IR) thermal imaging-based technique to enhance the object's detection in poor weather conditions is presented in this study. Moreover, it can be employed in unmanned aerial vehicles (UAVs) for road patrolling in unfavorable weather conditions including total darkness, fog, and heavy rain. The aim of this study is to automate the process of object detection which enhances road patrolling, where it can enforce the traffic safety compliances and provide automatic rescue call facilities in case of remote area fatalities. The proposed approach is comprised of three steps: (a) data acquisition, a dataset of 53 thermograms at various weather conditions has been created; (b) data processing, a thresholding method, morphological operations, and pseudo-coloring have been performed; and (c) results validation, compare the outcomes of proposed methodology with standard approaches. More specifically, the optimal temperature thresholding in conjunction with morphological operations automates the process of object detection, where the pseudo-coloring algorithm is introduced to convert the thermograms into RGB space which enhances the images for better visualization. Consequently, the proposed methodology shows a good accuracy of 83% for object detection in different weather conditions. The methodology can be used with UAVs which enables fast monitoring of recent accidents on remote locations as the clashing of vehicles raises the temperature. Besides, the issues and challenges faced in the thermal-based UAVs are also discussed.

N. Sharma · A. P. Singh
Department of Electronics and Communication Engineering, Sant Longowal Institute of Engineering & Technology, Longowal, Sangrur, Punjab, India

A. S. Arora (✉) · J. Singh
Department of Electrical & Instrumentation Engineering, Sant Longowal Institute of Engineering & Technology, Longowal, Sangrur, Punjab, India

© Springer Nature Switzerland AG 2020
R. Avtar, T. Watanabe (eds.), *Unmanned Aerial Vehicle: Applications in Agriculture and Environment*, https://doi.org/10.1007/978-3-030-27157-2_11

Photonic Crystal Fiber Sensor Based on Sensing Ring for Different Blood Components: Design and Analysis

Surinder Singh
Dept. of Electronic & Communication
Sant Longowal Institution of Engineering and Technology
Longowal -148106 (Punjab), India
surinder_sodhi@rediffmail.com

Veerpal kaur
Dept. of Electronic & Communication
Sant Longowal Institution of Engineering and Technology
Longowal-148106 (Punjab), India
kaur.veerpal617@gmail.com

Abstract— **This article proposed solid core PCF with sensing ring for different blood component detection. Analytical validation of proposed sensor has been done by using FEM numerical technique in term of relative sensitivity and confinement loss. In this PCF design, sensing liquid filled into uniform circular ring and evanescent field interact with sensing liquid for better light matter interaction. This proposed PCF sensor design overcome some experimental challenge such as leakage of light and sensing analyte loss during the displacement of sensing probe. This proposed inner circular channel overcome the drawback of external channel PCF probe. This uniform circular sensing ring around the core overcome the losses and support better evanescent field matter interaction for sensing application.**

Keywords— Evanescent field, FEM, RBCs, WBCs, Blood, components.

I. INTRODUCTION

Photonic crystal fiber offer outstanding potential in optical sensor technology and research interest increased remarkably in last decade due to increase the research publication, conference proceeding and patents. These micro structure holey fiber support unique band gap and modified total internal reflection propagation phenomenon that is not possible in conventional fiber system. Some prime factor which support unique sensing property are:(i) Photonic crystal fiber made from single silica material.(ii) various array design of air hole.(iii) infiltration of sensing liquid inside the air hole add extra degree of freedom for sensing application[1]. Several research group around the globe trying to fabricate the new design of PCF with unique sensing property. For commercialization of sensor, PCF sensor accepted by various fields such as food safety, liquid and gas detection, medical detection, biosensing, bioimaging and drug detection application [2]. This photonic sensing technology support new R&D opportunities for young scientist and scholar and open new gate way for strong business partnership in optical fiber sensor technology. The market share will reach US$4.33bn in 2018. PCF sensor has high sensitivity, high performance, low cost and flexible design. Knight *et al.*[3] fabricate first hexagonal PCF design [1996] and advance technology support different geometrical structure like octagonal (Ademgil *et al.* [4]), decagonal (Razzak *et al.*[5]), elliptical (Hao *et al.* [6]), honey comb cladding (Hou *et al.* [7]), hybrid core cladding (Ahmed *et al.* [8]) design. Hollow core PCF has high sensitivity, narrow transmission spectra and needed precise arrangement of air holes [9]. Further, solid core PCF becomes premium candidate to overcome the above limitation with low sensitivity [10]. Many researchers have reported to enhance the sensitivity of index guided PCF by different designs. Park *et al.* [11] reported high index GeO_2 doped silica ring surrounding the central hollow core for more sensitivity and lower confinement loss. Olyaee *et al.* [12] reported a modified structure of GeO_2 doped ring core PCF with hexagonal arrangement of air holes. Sensor performance improved with increase of inner holes diameter, core diameter, pitch and No of holes in layers. This sensor design has relative sensitivity 13.23 % and minimum confinement losses 3.77×10^{-6} dB/m. Morshed *et al.* [13] extended same work with four non-circle rings around the GeO_2 doped core and achieved sensitivity 16.88% and minimum confinement loss 1.765×10^{-8} dB/m. Morshed *et al.* [14] proposed same structure with optimized parameter for detection of CH_4, HF and various toxic gases in environment. This sensor achieved relative sensitivity more than 42.47% and confinement loss 4.783×10^{-6} dB/m. Morshed *et al.* [15] proposed the use of P_2O_5 in outer ring and compared the confinement loss with GeO_2 doped core. Kawsar *et al.* [16] proposed a hybrid design with core cladding is micro structure for benzene, ethanol and water detection. This proposed hybrid design has maximum sensitivity 49.29% and confinement loss 3.13×10^{-10} for benzene chemical. Dinish *et al.*[17] experimentally describe the use of hollow core PCF for cancer cell detection. This proposed sensing technique has minimum detection limit of protein 100 pg with sample volume around 10 nL. Chorpa *et al* [18] proposed a diamond ring resonator photonic crystal waveguide for disease detection. This proposed sensor simulatively detect cancer tissue, diabetes and blood component. All these reported PCF sensor analysed analytically and numerically. Finite element method (FEM) used to numerically investigate the sensor

978-1-5090-4749-9/17/$31.00 ©2017 IEEE

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:02:03 UTC from IEEE Xplore. Restrictions apply.

Determination of Soil Suitability for Agriculture Farming Using Microwave Analysis

Lakhvinder Singh Solanki,Surinder Singh,
Sant Longowal Institute of Engg. & Tech.
Longowal, District Sangrur, Punjab, India
lakhvinder_singh_solanki@yahoo.co.uk

Nandini Garg,
Sant Longowal Institute of Engg. & Tech.
Longowal, District Sangrur, Punjab, India
nandinigarg37@gmail.com

***Abstract*—This paper presents a compact and low cost system with rectangular microstrip patch antenna that can be used as a sensor for real time determination of the microwave properties of the agriculture land. Here, the rectangular microstrip patch antenna has been designed using ROGERS RT/ duroid 5880 (tm) for resonance frequency of the dry loamy soil. The dielectric constant of the soil samples with different % of moisture have been analyzed and a model has been proposed. It is interesting to observe that calculated dielectric constant of soil increases with increase in the % of the moisture in the soil samples and these variations have been due to the high dielectric constant of the water content in moist soil. By using the determined resonance frequency shift or dielectric constant of the sample, the suitable crops can be suggested.**

Keywords— Soil dielectric constant, Microstrip patch antenna, Soil moisture, Frequency shift, Effective dielectric constant.

I. INTRODUCTION

Soil moisture plays a vital role in small scale agriculture as well as on the large-scale modeling of interaction of land or atmosphere which is present in atmospheric cycle. Crops along with vegetation depend further on the moisture accessible at root level rather than on rainfall/precipitation amount. Regarding plan for irrigation, as well as the actual arrangement of irrigation action, water budgeting needs local information of soil moisture [1]. However, soil moisture has been rarely pragmatic regularly at meteorological stations and its quantity was left to hydrologists, agriculturalists and additional enthusiastical parties. Furthermore, recent urbanized soil moisture measurement techniques are more practicable for meteorological stations than most of the traditional methods.

In the agriculture (crop production) and botany (plant science fields), soil moisture measurement is needed to find out finest period to plant and cultivate the field. With quantity of moisture present in soil, modification in diverse materialistic and chemical properties of soil can be found. Moisture measurement is also needed to determine changes in infiltration or irrigation and also to analyse ground water renewal and evaporation-transpiration process. There is a great Significance in the fields like Hydrology, Forestry, and Agrology. Measurement of soil moisture is also required to study and decide the parameters likewise soil report, surface tension linked with civil and soil engineering.

Moisture content in soil is essential characteristic in agriculture, civil engineering and hydrology, since workability of a clayey soil strongly depends on its moisture content. Due to this reason, many of microwave sensors have been designed to give a real-time, simple, sensitive, small size and low cost for soil moisture measurement. In this paper, rectangular microstrip patch antenna is used as a sensor system proves to be an important tool aimed at improving soil performance and soil quality. The moisture properties of the soil have been analyzed by estimating the dielectric constant of soil. As there is frequency shift, and the effective dielectric constant is determined for soil moisture samples. In last a numerical model is proposed to determine the moisture % in the soil by knowing the resonance frequency drift.

II. MEASUREMENT OF SOIL MOISTURE

There are two different techniques to measure the soil water content;

(a) Direct Method - The water removal from the soil through the process of evaporation, leaching, or the chemical process is carried out and successive calculation of the amount of water removed. Direct measurements are inundated with troubles predominantly due to the necessity for destructive sampling. Measurements cannot be replicated on the similar sample of soil; therefore, repeated samples must be in taken from a plot at any one time to conclude the variation of the measurements at that time and so to permit the analyst to ascertain whether they differ significantly from determination on further occasions. The requirement for repetition can end result in the managing of very large number of samples. Further, replicated samples within the same circumference or area may well cause unacceptable harm to a crop (vegetation) or soil [2]-[5]. Gravimetric method is the usually

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:02:36 UTC from IEEE Xplore. Restrictions apply.

Distortion Cancellation for Solitons Carrying High Speed Information in WDM Systems

Nada Badraoui[1,2], Tibor Berceli[1], and Surinder Singh[3]

[1] *Broadband Infocomm. and Electromagnetics Dept., Budapest University of Technology and Economics, Budapest, Hungary, E-mail: nada.@hvt.bme.hu and berceli@hvt.bme.hu*

[2] *Formerly University 8 May, 1954 Guelma, Algeria*

[3] *Department of ECE, Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, Punjab, India, E-mail: surinder_sodhi@rediffmail.com*

ABSTRACT

The wavelength division multiplexing (WDM) type optical communication significantly increases the transmission capacity. However, one of the key issues is how we can reduce the pulse broadening and the interaction between the neighboring channels due to the nonlinear effects. The optical soliton offers the answer to this question. The soliton pulse can keep its shape during propagation, when there is a proper balance between the second order dispersion effect and the nonlinear Kerr effect, the main physical effects influencing the soliton propagation in fibers. Using the soliton approach, the pulse power has to be high enough to utilize the fiber non-linearity for keeping the pulse shape but its power has to be small enough to avoid the generation of higher order solitons. Simulations confirm our theoretical hypothesis for the design principles of soliton transmission in WDM systems. Due to new online filtering processes, soliton systems can now provide their benefits.

Keywords: solitons, wavelength division multiplexing (WDM), nonlinear effects in fibers, second order chromatic dispersion.

1. INTRODUCTION

Optical nonlinearities play a major role in optical fiber with respect to transmission capacity and performance of the system. They degrade the system performance, especially in wavelength division multiplexing (WDM) systems, where several channels are propagating simultaneously in the same fiber, resulting in high optical intensities. That can result in pulse distortion effects referred to as self-phase modulation (SPM), cross phase modulation (XPM), crosstalk between channels, and four wave mixing (FWM). However, the non-linearity also has many useful applications, especially for the implementation of all-optical functionalities. In an optical link applying dispersion management, i.e. when the chromatic dispersion is compensated for every channel then the EDFA type optical amplifier can be well applied amplification or regeneration. However, there are some constraints like channel spacing, amplifier noise, collision of solitons and cross talk between the channels. They become a serious problem with the increase in the number of channels due to the nonlinearity of the system [1].

This paper simulates two channel WDM optical communication systems in single mode fiber over long haul of 100 km to investigate the effect of SPM, XPM and FWM. Their thresholds, managements and applications are also discussed; and a comparative study of these effects is presented.

2. WAVELENGTH DIVISION MULTIPLEXING

Wavelength-division multiplexing (WDM) is a method of combining multiple signals on laser beams at various infrared (IR) wavelengths for transmission along fiber optic medium. Each IR channel carries several RF signals combined by means of FDM or time-division multiplexing (TDM). Each multiplexed IR channel is separated, and de-multiplexed into the original signals at the destination. Using FDM or TDM in each IR channel in combination with WDM or several IR channels, data in different formats and at different speeds can be transmitted simultaneously on a single fiber. The requirement for the next-generation of WDM systems, known as dense WDM (DWDM), is a channel spacing of less than 1 nm. It is obvious that the use of different sources to create the multiple wavelength channels places strict restrictions on their stability, cost, and maintenance [2].

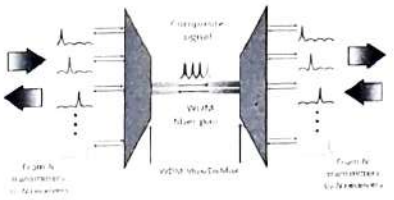


Figure 1. Optical emission and reception system in the WDM technology.

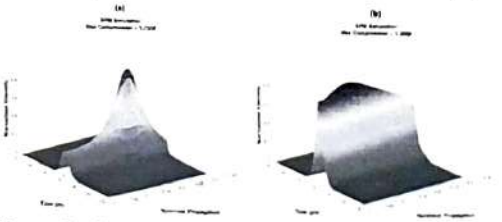


Figure 2. Illustration of the impact of SPM and XPM on the optical signal.

978-1-5386-0859-3/17/$31.00 ©2017 IEEE

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:05:00 UTC from IEEE Xplore. Restrictions apply.

Wavelength-Convertible Optical Switch Based on Cross-Gain Modulation Effect of SOA

Sukhbir Singh and Surinder Singh

Abstract All-optical switching based on wavelength conversion using cross-gain modulation (XGM) effect of semiconductor optical amplifier (SOA) has been proposed and demonstrated for 10 Gbps NRZ modulated data signals. Error-free operation is successfully achieved for converted signal with Q-factor of >28.96 at optimum input probe power of −8 dBm. The proposed simple and cost-effective structure of optical switch can be utilized for future ultra-fast optical switching circuit and to expand the optical network.

Keywords Cross-gain modulation (XGM) · Semiconductor optical amplifier Wavelength conversion · Optical switching

1 Introduction

With exponential growth in demand of more bandwidth due to internet traffic, ultra-fast optical transmission system needs ultra-fast photonics devices to provide efficient service to the users. For such applications, photonic devices such as all-optical logic gates, optical switches, optical amplifier, wavelength converter, optical time-division multiplexer and demultiplexer are widely used [1–5].

SOA-based all-optical interferometric switches and wavelength converter are widely used and attractive candidate for future high-speed all-optical signal processing because SOA has much advantageous as compared to other nonlinear devices. These devices are mainly based on the four-wave mixing (FWM), XGM, and cross-phase modulation effect (XPM) of SOA [6–11].

In this contribution, the proposed wavelength-convertible optical switch is based on XGM effect on SOA which can be utilized for optical switching and wavelength conversion to expand the optical network. The performance of optical switch for

S. Singh (✉) · S. Singh
Department of Electronics and Communication Engineering, Sant Longowal Institute of Engineering and Technology, Longowal 148106, Punjab, India
e-mail: Sukhbir.mrar@gmail.com

© Springer Nature Singapore Pte Ltd. 2018
D. Reddy Edla et al. (eds.), *Advances in Machine Learning and Data Science*,
Advances in Intelligent Systems and Computing 705,
https://doi.org/10.1007/978-981-10-8569-7_36

EFFICIENCY ESTIMATION OF ALL OPTICAL CONTENSION DETECTION IN OPTICAL ROUTER FOR 60 Gbps

DILBAG SINGH
Department of Electronics & Communication Engineering
Sant Longowal Institute of Engineering & Technology *Longowal, Sangrur, India*
dilbagapm@gmail.com

SURINDER SINGH
Department of Electronics & Communication Engineering
Sant Longowal Institute of Engineering & Technology *Longowal, Sangrur, India*
surinder_sodhi@rediffmail.com

Abstract— **In this paper, optical logic circuit based on XGM, FWM effect of single SOA symmetry for optical packet contention detection is presented. All the decisions making, and processing of incoming signals are performed in optical domain for data rate of 60 Gbps. The contention detector efficiency is analyzed for increase in input optical power with different pump power.**

Keywords—Contention Detection, SOA, FWM

I. INTRODUCTION

Data transmission capability of photonic communication is increasing every day and reaches around 100 Tb/s. The increasing demand for high speed internet connectivity raise the requirement of ultra-high-speed operation and networks with capability to process high traffic of optical packets. Most of the router operations are performed in electronic domain, which is the major cause of bottleneck for achieving ultra-high-speed operation [1]. All optical packet switching is an ideal method for the design of optical router with higher speed, improved stability, smaller size and higher integration feasibilities. All optical signal processing functions bit-pattern generation, label swapping [2] and packet switching decoder [3] have been developed by utilizing all-optical digital logic gates as the back- bone elements. SOA–MZI based all-optical logic gates (OR, AND, XOR and XNOR) at 40 Gbps and 120 Gbps also demonstrated [4] and claimed that XNOR has been realized directly from SOA–MZI without receiving any input from realized AND, OR and XOR gates. The all-optical processing is attractive in high-capacity core networks without optoelectronic conversions [5].

There are three potential ways of exploiting the nonlinear effect in SOA to perform AND, OR and XOR logic functions: cross gain modulation (XGM), cross phase modulation (XPM) and four wave mixing (FWM). SOA based schemes for the contention detection and resolution are more attractive than other schemes because SOA's shows many nonlinear effects, have compact size, consume lesser power and having ability to be integrated with other optical circuits.

II. SETUP DETAILS

Experimental setup shown in "Fig. 1" consist of optical signal A of wavelength 1549.3 nm from Lorentzian laser with line width of 10 MHz at 60 Gbps. The optical signal A is generated with non-return to zero (NRZ) format by using amplitude modulation. The data signal A is deterministic with polynomial number of 3. The optical data signal B at wavelength of 1550.7 nm feed by Lorentzian laser signal of 10 MHz at 60 Gbps. The optical data signal B is also generated using non-return to zero (NRZ) format by using amplitude modulation and it is deterministic with polynomial number of 1. Both signals are combined and applied to the one port of 50:50 optical coupler. An optical pump source at wavelength of 1557.3 nm with line width of 100 MHz is connected to the second input port of the optical coupler. One of the output of the optical coupler is applied to nonlinear SOA with parameters as given in the "Table I". On the receiving side, a notch filter is used with cut off wavelength of 1557.2 nm to observe the combined output of applied optical data signal. The contention detection is also observed at the beat wavelength of the applied data signals by using band pass filter (BPF). The power and quality of the detected optical signal is measured with the help of an optical analyser.

A. Block Diagram of the experimental setup

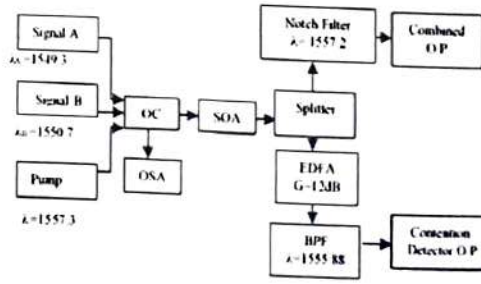


Fig. 1. Block diagram of experimental setup

978-1-5386-0933-0/18/$31.00 ©2018 IEEE

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:06:53 UTC from IEEE Xplore. Restrictions apply.

PHOTONICS-2018: International Conference on Fiber Optics and Photonics
December 12-15, 2018, IIT Delhi, New Delhi - 110016 India

Design Approach of All Optical Contention Detection Circuit

Vishal Sharma[b], Surinder Singh[b], Sukhbir Singh[c], Quang Minh NGO[d], Amin Malek Mohammadi[e]
[a]*Department of Electronics and Communication Engineering, Sant Longowal institute of Engineering and Technology, Longowal, Sangrur, Punjab, India-148106*
sharma1994vishal@gmail.com
[b]*Department of Electronics and Communication Engineering, Sant Longowal institute of Engineering and Technology, Longowal, Sangrur, Punjab, India-148106*
[c]*Department of Electronics and Communication Engineering, Sant Longowal institute of Engineering and Technology, Longowal, Sangrur, Punjab, India-148106*
[d]*Vietnam Academy of Science and Technology | VAST Institute of Material Science*
[e]*Department of Electrical and Electronic Engineering Malaysia Campus Jalan Broga 43500 Semenyih Selangor Darul Ehsan Malaysia*

Abstract: The Four Wave mixing (FWM) based contention detection circuit has the high performance in term of bit error rate for the contention detection signal. For the amelioration in the Quality factor, FWM is enhanced by the optimization in length, effective area of highly nonlinear fiber and the signal power.

1. Introduction

The network traffic increases day by day. It is approximately 70% to 150% increment in network traffic per year[1]. Because of this rapid increase in the network traffic, the future network should be capable of handling higher data rate in terms of Tb/s [2]. Current network is based on electronic signal processing operations, which have the limitation in the data rate because of delay provided by the wired interconnects in the signal processing device which create a bottleneck between the optical transmission media and signal processing device. The use of transparent signal processing device is one of the solution for this bottleneck occur between the optical transmission media and signal processing device[1].

In the network, when two signals from different input ports having same signal frequency enters the network at same time and contend toward the same output port, the problem of contention comes into the picture[1]. The contention can be detected by the exploitation of Four Wave Mixing (FWM) in the highly nonlinear fiber (HNLF). When multiple closely spaced optical signals having same polarization travel through HNLF, because of third order nonlinearity, FWM interaction occur inside HNLF, and new signals having frequency which is the combination of interacting signal frequencies generates inside HNLF[3]. The dependency of FWM signal on the input signal and the HNLF parameter is given in equation (2)[4].

$$f_w = f_p + f_q - f_r \tag{1}$$

$$\frac{dA_w(z)}{dz} + \frac{\alpha}{2} A_w(z) = i\frac{n_2 \omega_w}{cA_{eff}} A_p(z) A_q(z) A_r^*(z) e^{-i(\beta_p + \beta_q - \beta_r - \beta_w)z} \tag{2}$$

Here, in equation 1,2, fw is the FWM signal, and f_p, f_p, and f_r, are pump signal and data signal frequencies. Figure 1 shows the basic diagram, and Table 1 shows the logics used for the contention detection in the network.

Table 1: Logics for contention Detection in network

A	B	CD
0	0	0
0	1	0
1	0	0
1	1	1

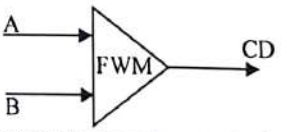


Figure 1: Basic diagram of the design for contention detection ,A: input signal A, B:Input signal B, CD: Contention detection output

In contention detection circuit, whenever both the signal inputs A and B are high at the same time there will be a contention in the network which is nothing just an AND logic in the network which can be designed by the FWM in optical nonlinear element.

2. Experimental Setup and Results

From the logic point of view, the circuit is not very complex. Figure 2 shows the experimental setup for the designed all optical contention detection circuit. In the architect, A and B are the two input data signals at the data rate of 40*Gbps* with ASK Modulation scheme having NRZ data format defined in the transmission section. The polarization of both the input data signals A and B are same for the FWM interaction in the HNLF. The wavelength for the data signal A and B is 1552*nm* .Both the signals contend toward the contention detection section along with pump signal

International Journal of Industrial Electronics and Electrical Engineering, ISSN(p): 2347-6982, ISSN(e): 2349-204X
Volume-6, Issue-9, Sep.-2018, http://ijieee.org.in

DEVELOPMENT OF CONFORMAL DIPOLE ANTENNA FOR BIOTELEMETRY APPLICATIONS

[1]RAJEEV KUMAR, [2]LAKHVINDER SINGH SOLANKI, [3]SURINDER SINGH

[1,2,3]Sant Longowal Institute of Engineering and Technology, Sangrur,Punjab
E-mail: [1]200rajeev@gmail.com, [2]lakhvinder_singh_solanki@yahoo.co.uk, [3]surinder_sodhi@sliet.ac.in

Abstract- In this paper, conformal dipole antenna is designed and simulated. A model of conformal dipole antenna is proposed using artificial neural network for biomedical application. Initially, a planar dipole is designed on thin flexible substrate Rogers RT/Duroid 6010 with dielectric constant (ε_r=10.2), loss tangent (δ=0.0023) and thickness of (h=10mil) for ISM band of 2.45 GHz frequency and then conform it on cylindrical surface. The dipole is conformed on cylinder of radius of curvature (R) from 8 mm to 110 mm with step size of 0.25mm. Three parameter; return loss, resonance frequency and bandwidth of conformal dipole antenna for different radius of curvature has been modeled using feed-forward back propagation neural network. The % mean square errors of neural network model are found to be 0.04%, 0.009% and 3.77% for return loss (S_{11}), resonance frequency (f_0) and bandwidth (BW) respectively. A non regression model for conformal antenna has been developed using curve fitting technique and proposed for biotelemetry applications.

Keywords- Conformal Antenna, Artificial Neural Network, Miniaturization, Curve Fitting.

I. INTRODUCTION

The growing demand of remote health care and expansion in medical application has become a reason for the evaluation of biomedical telemetry. Biomedical telemetry deals with sensing biological parameters of human body and sends it to the control unit. These devices are called as wireless body centric devices. It is specially used to monitor patient of remote location [1]. Wireless body centric sensing devices are available in many types and can be categorized according to the placement of the device around human body. The on-body wearable devices such as smart watch, smart band etc. have become popular these days. The devices are embedded with sensors having lots of functions such as heart beat monitoring, calories consumption calculation, path tracking etc. these wearable devices are connected with monitoring unit via wearable antenna or on-body antenna acts as repeater antenna and provide channel between other body worn devices [2]. Implantable medical devices (IMDs) and ingestible capsule are categorized as in body medical devices. Implantable medical devices are presently working for wide verity of applications such as blood pressure monitoring, glucose level monitoring [3], pacemaker, retinal implant, temperature monitoring etc. On the other hand ingestible capsule [4] provide real time monitoring inside the human body and can be able to replace painful endoscopy systems. As implantable and capsule devices are very small, designing of antenna for these devices are one of the biggest challenge. Especially in-body medical devices, an efficient antenna should be able in two way communication [5]. Compact size, efficiency, effect of surrounding environment, biocompatibility, short circuit problem are important antenna design requirements [6].

Numerous techniques have been suggested for antenna miniaturization of biomedical devices. Planer inverted F antenna can reduce the physical size of antenna by upto 50% by using shorting pin method [7]. Lengthening of the current path of antenna using spiral [6], meandering [7] and serpentine [3] shape also help to reduce the antenna size significantly. Conforming the antenna on cylindrical body as used in ingestible capsule can also reduce the antenna size[4] [8]. The behavior of planer and conformal antenna is far different, so it is required to analyze the performance behavior of planer antenna while modifying it into conformal shape. The main objective of this paper is to analyze the performance parameter of conformal antenna for ingestible capsule endoscopic system. Rectangular microstrip antenna, [9] and circular antenna [10] has studied earlier. A planer dipole antenna is designed on thin and high dielectric substrate material for resonance frequency 2.45GHz free ISM band. Substrate of the planer dipole is subjected to conform on cylindrical shape. In this paper a model has been developed using artificial neural network and curve fitting technique on behalf of conformal behavior of dipole antenna parameter for different radius of curvature (8 to 110mm) and proposed for biotelemetry applications.

II. ANTENNA DESIGN

2.1. Planar Dipole

A conventional planar dipole antenna is considered due to its simple structure. Planer dipole consists of pair of metal sheet arm placed in 180^0 apart from each other. Frequency of resonance of planer dipole is a factor of total length of dipole is probably taken as half of effective wavelength (λ_{eff}) and effective dielectric constant (ε_{eff}) of substrate [11] is given in equation (1) & (2).

Miniature Archimedean Spiral PIFA Antennas for Biomedical Implantable Devices

[1]Rajeev Kumar, [2]Lakhvinder Singh Solanki, [3]Surinder Singh

[1,2,3]Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab
Email: [1]200rajeev@gmail.com, [2]lakhvinder_singh_solanki@yahoo.co.uk, [3]surinder_sodhi@sliet.ac.in

Abstract—**In this present work, Miniature multilayer Archimedean spiral PIFA antennas for biomedical implantable devices is proposed. The antenna design is proposed to resonate at MICS (402-405MHz) and ISM Band (433-435MHz). The overall volume of design is less than 60 mm^3. The present design is supposed to work inside human muscle tissue. Frequency dependent numerical homogeneous human muscle tissue model has been used for initial design. The design is simulated and validated by comprising the result from two different simulator HFSS based on Finite-Element Method (FEM) and CST microwave studio suite based on Finite-Difference Time-Domain (FDTD) Method. The design is quite simple to achieve 50 real impedance matching by adjusting the feed and shorting pin over spiral axis. Due to high impedance matching upto -42dB and -25dB of reflection coefficient (S_{11}) has been achieved for MICS band and ISM band design. Maximum achieved gain of proposed design is -38dBi and -40.1dBi respectively. The performance of the proposed antenna design is also analyzed inside the various human body tissue models.**

Keywords- Implantable antenna, Archimedean spiral, biomedical application, implantable medical devices, PIFA.

I. INTRODUCTION

Remote health monitoring is a magnificent emerging technology adopting by doctors now a day. Due to hectic and busy day to day life, early detection of diseases such as chronic heart disease, diabetes, breast cancer[1], hyperthermia, hypertension, chronic obstructive pulmonary disease (COPD) [2], sleep apnea and many more has become prime requirement these days. Biomedical telemetry provides the solution by sensing the biological signal and communicates with wireless body centric system. Biomedical telemetry deals with sensing of biological signal and communication with wireless body centric communication system at a distance via antenna system. Wireless body centric communication systems are classified in three ways; on body, off body and in body communication system [3]. On body devices are mounted on human body eg. Wearable device, Smart band used to sense pulse rate, pulse oxymeter etc. off body devices are connected with other device with some distance. In body communication system are Implantable medical devices (IMDs) embedded with high tech sensors are being using to monitor any vital signs of the patients and maintain the record of every minute of the day and can transmit the signal to diagnostic center or patient's portable device. Pacemaker , implanted cardiac defibrillators (ICD), glucose monitoring [4], oral implants [5] etc. are common implantable medical devices used for health parameters monitoring for treatment purpose [6]. Neurostimulators are very popular devices have been used for continuous monitoring of patient's body temperate, Wireless Brain machine interface system [7], heart rate etc. The attention of the present work is on the antenna systems that are being used to provide maintenance free communication link between wireless body centric implantable devices. Miniature size and biocompatibility are most the essential requirement of antenna for implantable devices. IMDs are specially designed to work on medical implant communication service MICS band (402MHz to 405MHz) created by Federal Communications Commission (FCC)[8] suggested for implantable application due to high support of communication conductivity and data rate [9]. ISM frequency band (433MHz to 435MHz) is also preferred as both bands are quit closer to each other. For such a low frequency, required antenna length is quit larger. Use of high dielectric layer Rogers RT/ duriod 6010 (ε_r=10.2), Rogers 3210 (ε_r=10.2), alumina ceramic (ε_r=9.2) are suggested for size reduction. Increasing of electrical path using meander line, spiral, sprinter, hook slot with shortening pin called as planer inverted F antenna (PIFA) helps in size reduction up to 60% [10].

The present work is a miniature sized multilayer Archimedean spiral PIFA antenna design inspired from [11] and [12] proposed to work at MICS & ISM band. Archimedean spiral is simple in design with good space filling property that helps in increasing the electrical length of antenna. The details are discussed in antenna design and result section.

II. ANTENNA DESIGN & TECHNIQUES

A. Antenna design

The proposed antenna design is a multilayer Archimedean spiral PIFA antenna with coaxial probe feeding. The architecture of Archimedean spiral is shown in Figure 1. In polar coordinate system (r,θ) the spiral can be expressed by equation [13]

$$r = a + b\theta \tag{1}$$

$$b = \frac{w+G_p}{2\pi} \tag{2}$$

Where r is the distance of spiral locus from center, a is initial radius of spiral from the origin, b is the growth rate, w is width of the spiral, G_p is the gap between two adjacent spiral arm

978-1-7281-1380-7/19/$31.00 ©2019 IEEE

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:10:40 UTC from IEEE Xplore. Restrictions apply.

SAR Analysis of Antenna Implanted inside Homogeneous Human Tissue Phantom

[1]Rajeev Kumar, [2]Lakhvinder Singh Solanki, [3]Surinder Singh
[1,2,3]Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab
Email: [1]200rajeev@gmail.com, [2]lakhvinder_singh_solanki@yahoo.co.uk, [3]surinder_sodhi@sliet.ac.in

Abstract—**In this paper, specific absorption rate (SAR) field of planer inverted F antenna (PIFA) inside the numerical homogeneous human muscle phantom model is investigated. Two antennas; meander PIFA and wrinkle PIFA are implanted and simulated to resonate at 2.4 GHz. The size of the proposed design is 25 x 22.4 mm on 20mil thick Rogers RT/ duroid 5880 substrate. The proposed design claims ultra wide band property with more than 1.5 GHz bandwidth. The SAR value of different simulating human tissue is obtained up to 30 mm away from antenna. The maximum average SAR value of antenna inside human muscle tissue is obtained to be 0.87W/kg and 2.1W/kg at 1mm distance from antenna plane. The design conveys quite good gain inside conducting lossy tissue comes to be -21.57 dB and -22.3dB.**

Keywords- Specific absorption rate (SAR), PIFA antenna, homogeneous human phantom, (key words)

I. INTRODUCTION

Wireless communication systems have become an essential in today's life style and will be a future most dominating technology. Today everyone is encircled by wireless devices having verity of applications. In the past few years, these wireless devices are getting attracted towards multi feature application such as healthcare, entrainment, military and sports etc embedded in a single system. In this regard the wireless body area networks (BANs) supports reliable communication between on body and in body implantable devices [1]. These devices are continuously emitting the electromagnetic waves through antennas embedded in wireless devices exposed to very close proximity of human body. Human body is a non homogeneous lossey high dielectric conducting medium for electromagnetic waves and hence it exhibit good absorption property. This absorption of EM waves via human body can cause adverse effect on human health. Specific absorption rate (SAR) is a parameter that conveys the information about the absorption of EM wave exposed to human body [2]. The SAR value is directly dependent upon the conductivity of the lossy dielectric medium and surrounded electric field. SAR is a scalar quantity can be expressed in an average on the surface or within the body with 1g or 10 gm of tissue and it defined by:

$$SAR(r) = \frac{\sigma|E(r)^2|}{2\rho} \qquad (1)$$

Where, E (V/m) is root mean square value of electric field at a distance (r). σ(S/m) is the conductivity of the medium and ρ (kg/m^3) is medium density. The SAR is well defined as the power absorbed by a medium in watt per kilogram. As per IEEE C95.1-1999 standard and IEEE C95.1-2005 [3] standard SAR level restricts a limit over RF radiating device for safety concern and is calculated over 1g of cubic shaped human tissue to less than 1.6W/kg (SAR 1 g, max ≤ 1.6 W/kg) [4]. Another SAR standard is presented by International Commission on Non-Ionizing Radiation Protection (ICNIRP) over 10g of human tissue with nearly homogeneous electrical properties in cubical shape to less than 2W/kg [5].

SAR field analyses have been reported by many researchers in homogeneous canonical phantom. Single layered phantom model of skin [6], [7], muscle [8], [9], brain tissue[10],[11] have been used for testing the SAR performance of antenna. In [12] experimental investigation of SAR is carried out inside large sized rectangular phantom model. [13] Investigated the effect on human child head model in overexposed RF environment using numerical anatomical model. Numerical simulation is a good effort to analyze the antenna performance. The final design may further fabricated and tested in real environment.

The work presented in this paper is focusing on the SAR value analysis based on numerical modeling of human tissue. Three antenna designs are supposed to implant inside the homogeneous human muscle are considered for SAR observation. A part from introduction the paper is sub divided into four sections; antenna design and geometry, human body modeling, results and discussion followed by conclusion.

II. DESIGN & TECHNIQUES

A. Antenna design

In this paper, numerical model of planer inverted F antenna (PIFA) implanted inside the canonical homogeneous muscle phantom model is presented. Two modified coplanar PIFA design has been considered for the analysis at 2.4 GHz. One is meandered PIFA, considered here as reference antenna [14]and another design is wrinkle PIFA. In Wrinkle PIFA is a modified meander monopole antenna with folded radiating element. The length of radiating element is managed to resonate at 2.4 GHz ISM band. Both proposed antenna designs are designed on Rogers RT/ duroid 5880 substrate (ε_r =2.2 and tanδ=0.0009) with substrate thickness of 20 mil. The substrate dimension is 30 x 14 mm and 25 x 22.4 mm for antenna_1 & antenna_2 respectively. The antenna is mounted with superstrate layer of same material in order to provide proper isolation from radiating patch with human tissue. The ground of both antenna designs is as L shaped in order to achieve compact design with efficient performance. Fig 1 and Fig 2 shows the physical

978-1-7281-1380-7/19/$31.00 ©2019 IEEE

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:11:18 UTC from IEEE Xplore. Restrictions apply.

Deformation Analysis of UWB Microstrip Antenna for Breast Cancer Detection

Beerpal Kaur, Lakhvinder Singh Solanki and Surinder Singh

Abstract This paper presents a novel antenna structure for body diagnosis and detection system. The antenna structure is simple to fabricate and looks like a curved structure, which is easy to place on human body's curved parts. The proposed antenna consists of rectangular patch and rectangular fractal-based defected ground. The rectangular patch has one round cut at each corner. It is fed with coaxial cable and can easily be integrated with an array of multiple elements. The antenna parameters like, S_{11}, total gain, radiation pattern, polar pattern in various planes and VSWR were evaluated for various degrees of deformation of the planner patch antenna and are compared with the conventional planner antenna. The antenna retained its various parameters within permissible limits even after deformation. The proposed antenna is suitable candidate for designing a breast cancer detection system.

Keywords Antenna · Curved · Rectangular patch · Breast cancer · On body · Detection system · Array · Electromagnetic defected ground (EBG)

1 Introduction

Cancer is a given name to any type of malignant tumor that spread rapidly to the rest of the body. Every year, more than one million people in the world are diagnosed with different types of cancers. Statistics show that breast cancer is one of the most frequent types of tumor that affect women worldwide, especially in developing countries [1]. This type of cancer overtook lung cancer which used to top the list worldwide with 1.6 million of diagnostics and death rate in 2012. In previous medical examination of year 2008, a hike of 20% in the breast cancer cases and 14% of normal cases has been observed. About 2 million women were diagnosed with breast cancer in

B. Kaur (✉) · L. S. Solanki · S. Singh
Sant Longowal Institute of Engineering and Technology, Longowal,
Distt Sangrur 148106, India
e-mail: bawabeerpal335@gmail.com

L. S. Solanki
e-mail: lakhvinder_singh_solanki@yahoo.co.uk

© Springer Nature Singapore Pte Ltd. 2020

A. K. Luhach et al. (eds.), *First International Conference on Sustainable Technologies for Computational Intelligence*, Advances in Intelligent Systems and Computing 1045,
https://doi.org/10.1007/978-981-15-0029-9_17

 ISBN 978-604-913-088-5

SURFACE PLASMON RESONANCE SENSOR BASED ON PHOTONIC CRYSTAL FIBER COATED WITH GOLD FILM

Cam Thi Hong Hoang[1], Minh Quang Ngo[1], Dai Van Pham[2], Son Thanh Pham[2], Vinod Kumar Verma[3], Amit Kumar Shakya[4], Veerpal Kaur[4], Sukhbir Singh[4], Surinder Singh[4]

[1]*University of Science and Technology of Hanoi, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam*

[2]*Institute of Materials Science, VAST, 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam*

[3]*Department of Computer Science and Engineering, Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, Punjab 148106, India*

[4] *Department of Electronics and Communication Engineering, Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, Punjab 148106, India*

E-mail: surinder_sodhi@sliet.ac.in; daipv@ims.vast.ac.vn

Abstract. In this paper, the high sensitivity surface plasmon resonance (SPR) sensor based on the photonic crystal fiber (PCF) with the gold-metal coating is proposed and numerically analyzed. The Finite Element (FE) based numerical technique has been used to solve the Maxwell equation with perfect matched boundary conditions. Sensing liquid filled into large size six air holes which are arranged in a hexagonal pattern. Among these six air holes, four air holes are coated with gold material to excite the plasmonic mode and light propagate inside the core region. By optimizing the structural parameters, the proposed design exhibits maximum wavelength sensitivity of 5000 nm/RIU with detection limit 1.34-1.39. The proposed sensor design could be used in various sensing applications, e.g., for chemicals, biochemicals, organics, and other lower-index liquids.

Keywords: *Photonic crystal fiber, Surface plasmonic resonance, Sensing*

I. INTRODUCTION

PCF-SPR sensors have been extensively used in a wide range of sensing applications such as hemoglobin content blood glucose, food quality control, virus detection, bio-engineering, medical diagnostics, antibody-antigen interaction, etc. [1-6]. The selection of plasmonic materials is very important to build a high-performance PCF-SPR sensor. Gold (Au) is a suitable candidate which is chemically stable in an aqueous environment, does not oxidize easily and also possesses a large resonance peak shift [7]. The SPR technique was first introduced for bio-sensing on the basis of prism coupling in 1983 by Liedberg et al. [8]. The PCF-SPR sensor works on the basis of the plasmonic medium with evanescent field interaction. Light penetration through the cladding results in an evanescent field, which excites the free electrons of the metal film at a particular wavelength when a resonance condition is satisfied, propagates along with the metal-dielectric interface [1,9].

Different methods have been analyzed for better sensing performance, those can be categorized into external sensing and internal sensing techniques [3,10,11]. Selective liquid infiltration into air holes is required for the internal sensing technique, which is quite challenging in terms of fabrication [1,3,12]. Generally, reported PCF-SPR sensors have been investigated by the wavelength interrogation method and amplitude interrogation method to show sensing performance. Recently, Jitendra *et al.* put a film of conducting metal oxide on six liquid analyte channels [13], the maximum wavelength sensitivity reached 2000 nm/RIU and has a resolution of 5×10^{-5} RIU. The PCF-SPR sensor with an external gold-coated film reached the maximum

(ECO-005)

Parametric Analysis of Implantable Spiral PIFA Antenna for Biotelemetry Application

Rajeev Kumar[1], Lakhvinder Singh Solanki[2], Surinder Singh[3]

[1,2,3]*Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab,India*

[1]rajeevkumar@sliet.co.in, [2]lakhvinder_singh_solanki@yahoo.co.uk, [3]surinder_sodhi@sliet.ac.in

Abstract

In this paper, parametric analysis of co-planer spiral PIFA is carried out for implantable medical devices. The effect of antenna spiral size, PIFA and feed location has been analyzed on the resonance frequency. The antenna design is proposed to work at 2.45GHz ISM band inside the human muscle. The antenna performance is investigated in terms of reflection coefficient, gain and radiation pattern. The proposed antenna design can also achieve UWB performance by selecting the appropriate feed location. The max gain achieved is -10.52 dB with the bandwidth of 1GHz.

Introduction

Bio telemetry is a branch of study that deals with data communication over a distance for medical purpose. It involves remote health care monitoring of any vital sign of patients or a person under study and send the biological information to doctor or health care unit. A wireless telemetry system can monitor real time physiological parameters such as ECG, EEG, heartbeat, glucose level, and temperature of body part, breast cancer detection[1] etc. of ambulatory patient to provide information such as consultation, diagnosis, observation, and treatment etc [2]. Wireless medical device implanted inside the human body for diagnosis and controlling consist of bio sensor, signal processing circuit and miniature microstrip antenna.

This paper is focusing on the development of microstrip antenna for implantable medical devices constrained to perform inside the human body. The electromagnetic behavior of the human body is categories with high diversity in terms of its electrical characteristics. Every part of human tissues has different electrical parameter in terms of permittivity and conductivity [3]. This diversity is depending upon the amount of moisture content in the tissues. So it is quit challenging to design antenna to work inside such medium. The prime design requirement of implantable antenna is miniaturization, biocompatibility and specific absorption rate (SAR) [4]. Too many researchers have suggested the miniature antennas using Meander line [5], serpentine line, multi layering of patch in the literature. These shapes help to increase the effective current path of antenna in a small space. Planer inverted F antenna (PIFA) can also used to reduce the antenna size by 50% [6]. On behalf of literature survey, this paper is proposing a miniature sized co planer spiral PIFA with dual shorting post antenna to resonate at 2.45GHz ISM band frequency. A parametric study is carried out on the basis of reflection coefficient, impedance, radiation pattern and the gain.

Methodology

The antenna is designed on 15 x 15 mm Rogers RT/ Duriod 5880 (ε_r = 2.2 and tanδ = 0.0023) with the thickness of 20mil. Fig 1 shows the top view of

Implementation of XOR Gate Using a Nonlinear Polarization Rotation in Highly Nonlinear Fiber

Vasundhara, Lovkesh, and Surinder Singh

Abstract In this paper, XOR gate is implemented based on nonlinear polarization rotation, initiated by Kerr effect in a single highly nonlinear fiber (HNLF) having length of 5 km and bit rate of 20 Gbps. Two cross-polarized inputs and polarization controller are used to control the Azimuth and ellipticity angle for the different input powers. Quality factor is analyzed versus different input power, extinction ratio, Azimuth, and ellipticity angle over various length of an optical fiber. Erbium-doped fiber amplifier (EDFA) is used for its nonlinear property and fast response time for the generation of XOR logic output.

Keywords Nonlinear fiber optics · EDFA · Polarization rotation · Optical fiber communication

1 Introduction

The problem of speed limitations of electronic devices is needed to be solved by using an all optical signal processing network. The optical logic gate plays a crucial role to tackle this issue. These gates are used in the number of applications such as bit error monitoring, switching triode, optical communication, designing of half adder, ultra-high speed pattern generation and recognition, and data encoding and decoding circuits. Optical logic gates are implemented by considering nonlinear effects in semiconductor optical amplifier (SOA), highly nonlinear fiber (HNLF) [1, 2]. In SOA, slow recovery time reduces the speed of operation but EDFA provides fast output response. Various techniques are used for achieving the XOR function based on the utilization of integrated Mach–Zehnder interferometer based on SOA,

Vasundhara (✉) · S. Singh
Department of Sant, Longowol Institution of Engineering and Technology, Longowal, Punjab 148106, India

Lovkesh
Department of Electronics and Communication, Punjabi University, Patiala, Punjab, India

S. Singh
Indian Institute of Information Technology, Una, Himachal Pradesh, India

© The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2022

M. Tiwari et al. (eds.), *Optical and Wireless Technologies*, Lecture Notes in Electrical Engineering 771, https://doi.org/10.1007/978-981-16-2818-4_23

D-Shaped Photonic Crystal Fiber Based Surface Plasmon Resonance Sensor Using Dual Coating of Metal Oxide for Healthcare Applications

Veerpal Kaur
Electronics and Communication Engineering Sant Longowal Institute of Engineering and Technology
Punjab, India
veerpalkaur@sliet.ac.in

Surinder Singh
Electronics and Communication Engineering Sant Longowal Institute of Engineering and Technology
Punjab, India
surinder_sodhi@sliet.ac.in

Abstract — **The phenomenon of surface plasmon resonance (SPR) is the basis of adsorption measurements for many tools that have resulted in several sensor applications. In this paper, a D-shaped photonic crystal fiber (PCF) based surface plasmon resonance (SPR) sensor with dual coating of conducting metal oxide is proposed. A brief study is performed to analyze the use of dual coated metal oxide plasmonic material to sense the lower refractive index (RI) chemicals. Firstly, the flat surface of photonic crystal fiber is coated with Indium Tin Oxide (ITO) followed by a coat of Zinc Oxide (ZnO) to enhance the plasmon-polariton generation. The SPR wavelength is tuned to the infrared region by changing the metal doping concentration. The external flat surface of the sensor is more convenient for liquid infiltration than liquid filling into small circular holes in conventional PCF sensors. The proposed sensor design has maximum wavelength sensitivity of 10000 nm/RIU in the RI detection range of 1.30-1.38 with a resolution of 2.0×10^{-5} and can be utilized specifically in the lab-on-chip technology for healthcare industry.**

Keywords—photonic crystal fiber, surface plasmon resonance, biosensor, nanodevices

I. Introduction

The photonic plasmonic sensors have a wide range of applications in multiple areas including, food safety, microscopy, drug discovery, medical inspection, disease diagnostics, chemical and biochemical sensing [1]. A light-matter interaction-based photonic plasmonic technology provides high sensitivity and selectivity and has also been credited to enhance the processing speed for sensing applications. This technology acts as a bridge between nanoscale electronics (frequency below few THz) and high-speed photonics (frequency more than 500 THz) and also allows for high bandwidth and data carry capacity above the terahertz range which justifies the association of SPRs with many healthcare products. Further, photonics based devices including fiber based MRI, cell growth bioreactors, advanced microscopes and certain portable medical devices provide quick and accurate analysis of medical conditions like, diabetes, HIV, Covid-19, cancer and also general health parameters which has provided a great incentive to perform further research and bring out advanced results for the medical community.

A broad range of plasmonic materials such as non-noble metals, semiconductors, 2D materials, doped metal oxides, etc., has opened new avenues for photonic medical devices. The recently invented 2D materials such as graphene, black phosphorus, Li^+ doping in MoS_2 (Molybdenum disulfide) supports shift in resonance to longer wavelength, which is required for biomaterial marking of samples having wavelength sized features [2-3]. Also, advanced fabrication techniques such as impulse magnetron sputtering, high pressure chemical vapor deposition, plasma-assisted atomic layer deposition at low temperature and pulsed laser coating techniques have enabled the feasibility of these miniaturized nanosensors [4-7].

In the last few decades, several D-shaped photonic sensors have been investigated. In 2016, Dash et al. described such a sensor with wavelength sensitivity of 5200 nm/ RIU, resolution of 1.92×10^{-5}, and operating wavelength 1600-2100 nm [8]. Rahul et al. also suggested a D-shaped plasmonic sensor, which had an average sensitivity of 7700 nm/RIU, resolution of 1.30×10^{-5} RIU, and analyte detection range is 1.43-1.46 [9]. Wu et al. came up with multiple designs having wavelength sensitivities of 21,700 nm/RIU and 31,000 nm/RIU respectively [10-11]. Chen et al proposed a PCF-SPR design with a sensitivity of 11055 nm/RIU and resolution at 9.05×10^{-5} with an operating range of 2.35 to 2.65 μm [12]. These designs have high propagation loss (~ 600 dB/cm) and a lower detection limit (1.33-1.39). The higher losses of the sensor, single-mode fibers channel losses and splice losses make the practical adaptation of these sensors extremely challenging [13-14]. Moreover, the available sensors are suitable for high RI analytes only and were operated in the visible region of the spectrum. The proposed design overcomes these limitations as it has a low propagation loss (35 dB/cm) and operates over a larger RI detection range (1.30-1.38) which is necessary in most practical applications. The operating wavelength of this sensor design is identified in the mid-infrared region. The proposed design can be utilized in applications involving detection of cancer tissues, diabetic tissues, food-borne pathogens, toxic methanol (1.314), intestinal mucosa of humans (1.328-1.338), various blood components such as hemoglobin (1.38), plasma (1.34), water (1.33), and white blood cells (1.36).

The design of the proposed sensor is elaborated in section II followed by results and discussion in section III and conclusion in section IV.

II. D- Shaped Sensor Design Description

Figure 1 shows the schematic diagram of this proposed sensor design. The diameter along horizontal direction is 22 μm, and the height along vertical direction is 20 μm. The smoother side of fiber is first coated with ITO

2021 IEEE 16th Nanotechnology Materials and Devices Conference (NMDC) | 978-1-6654-1892-8/21/$31.00 ©2021 IEEE | DOI: 10.1109/NMDC50713.2021.9677553

978-1-6654-1892-8/21/$31.00 ©2021 IEEE

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:18:42 UTC from IEEE Xplore. Restrictions apply.

2022 12th International Conference on Cloud Computing, Data Science & Engineering (Confluence) | 978-1-6654-3701-1/22/$31.00 ©2022 IEEE | DOI: 10.1109/Confluence52989.2022.9734120

Designing of a Novel PCF Biosensor having Octagonal Core and based on SPR for Chemical and Heavy Metal Sensing

Amit Kumar Shakya
Department of ECE
Sant Longowal Institute of Engineering and Technology,
(SLIET), Sangrur, Punjab, India

Email: pec1804_amit@sliet.ac.in

Surinder Singh
Department of ECE
Sant Longowal Insititute of Engineering and Technology,
(SLIET), Sangrur, Punjab, India

Email: surinder_sodhi@rediffmail.com

Abstract: **A novel model of the "photonic crystal fiber (*PCF*)" "surface plasmon resonance (*SPR*)" biosensor is presented in this work. The sensor is designed in a manner that it can develop eight cores. The sensor can detect analytes, chemicals, heavy metals embedded water samples, water samples, etc. The metal deposition technique at the outer end of the *PCF* is used in the "proposed sensor design" to deposit plasmonic material. Sensor parameters are calculated in terms of "wavelength sensitivity," "amplitude sensitivity," "sensor resolution," "linear relationship between refractive index and resonance wavelength." Finally, the designed sensor has presented reasonable sensing parameters better than the reported sensors in recent times.**

Keywords: **"photonic crystal fiber"; "surface plasmon resonance"; "wavelength sensitivity," "amplitude sensitivity," "sensor resolution."**

I. INTRODUCTION

"Photonics crystal fiber (*PCF*)" is an exciting platform used to build surface plasmon resonance (*SPR*) based biosensors [1]. The main advantage of these sensors is they require a small amount of analyte for detection purposes. These analytes or chemicals are identified based on their refractive index values. Thus it can be assumed that any liquid can be specified and detected from the biosensor. But these biosensors work in a particular range of the refractive index. These biosensors are designed using three different methodologies like "internal metal deposition (*IMD*)", "external metal deposition (*EMD*)" and on "*D* shaped fiber" [2]. Every design methodology has its pro and cons, but *EMD* based fibers are easy to fabricate. Thus this technique is preferred over other methods of *PCF SPR* sensor designing.

The detection ability of the *PCF SPR* sensor is calculated using sensing parameters like "wavelength sensitivity (*WS*)," "amplitude sensitivity (*AS*)," "sensor resolution (*SR*)" "linear relationship between resonance wavelength and refractive index." Besides, some more parameters like "full-wave half maximum (*FWHM*)" and "figure of merit (*FOM*)" also produce valuable information about the sensor detection ability.

Several scientists have developed *PCF* based *SPR* sensors for sensing a variety of analytes. Their sensors are different from conventional sensors based on various parameters like design, materials, sensing parameters, etc. Noticeably, work done by multiple scientists enlisting in the field of *PCF SPR* sensors is discussed as follows. Some of the excellent work done in the area of *PCF SPR* sensor is presented in these reviews.

Gao et al. [3] developed a *PCF SPR* sensor with only six air holes. They used a thin layer of gold (*Au*) over titanium dioxide TiO_2 as a plasmonic material. Their sensor can operate in the infrared region and obtain a resolution of 2.5×10^{-5} *RIU* for detecting aqueous analytes. *Hasan et al.* [4] developed a *PCF SPR* sensor having spiral geometrical structure. The plasmonic material used in their research is *Au*. Their designed sensor is able to detect various biological, chemical, and biomolecules analytes. *Yang et al.* [5] developed a *PCF SPR* sensor which exhibits strong birefringence behavior. They have used silver (*Ag*) coated over graphene layer as a plasmonic material through this sensor they have obtained a resolution of 3.97×10^{-5} *RIU*. *Dash et.al* [6] developed a *PCF SPR* sensor for refractive index sensing they have used aluminum-doped zinc oxide (*AZO*) as a "plasmonic material". They have obtained a high amplitude sensitivity of 167 RIU^{-1}. *Liu et.al* [7] designed a *PCF SPR* sensor to detect chemicals with lower refractive index varying from 1.00 *RIU* to 1.430 *RIU*. There designed sensor they have obtained wavelength sensitivity of 6300 nm/RIU. *Thenmozhi et.al* [8] developed a $D-$ shaped *PCF SPR* sensor having *Au* coating as a excitation material. This sensor performs very effectively under Infra-red region through this sensor they have obtained sensitivity of 50,000 nm/RIU and resolution of 2×10^{-6} *RIU*. *Dash et. al* [9] deigned a biosensor made up of "polymethyl methacrylate" they have used indium tin oxide (*ITO*) as a plasmonic material there presented biosensor gives sensitivity of 2000 nm/RIU and resolution of 5×10^{-5} *RIU*. *Rifat et.al* [10] designed a *PCF* based *SPR* biosensor for external analyte sensing they have used *Au* as a plasmonic material and obtained "wavelength sensitivity" of 4000 nm/RIU, "amplitude sensitivity" of 478 RIU^{-1} and "sensor resolution" of 2.5×10^{-5} *RIU*. *Hossain et al.* [11] developed a *PCF* based *SPR* sensor based on $D-$ shaped *PCF* though which various chemicals can be detected and investigated through the change in the refractive index value simultaneously. They have sensed the wavelength sensitivity of 15000 nm/RIU through their designed sensor and obtained the sensitivity of 6.66×10^{-6} *RIU*. *Sakib et al.* [12] presented a $DD-PCF-SPR$ biosensor to investigate analytes having refractive index values of *RI* 1.46, *RI* 1.47 and *RI* 1.48. Through their

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:19:37 UTC from IEEE Xplore. Restrictions apply

2022 12th International Conference on Cloud Computing, Data Science & Engineering (Confluence) | 978-1-6654-3701-1/22/$31.00 ©2022 IEEE | DOI: 10.1109/Confluence52989.2022.9734120

Designing of a Novel PCF Biosensor having Octagonal Core and based on SPR for Chemical and Heavy Metal Sensing

Amit Kumar Shakya
Department of ECE
Sant Longowal Insititute of Engineering and Technology,
(SLIET), Sangrur, Punjab, India

Email: pec1804_amit@sliet.ac.in

Surinder Singh
Department of ECE
Sant Longowal Insititute of Engineering and Technology,
(SLIET), Sangrur, Punjab, India

Email: surinder_sodhi@rediffmail.com

Abstract: **A novel model of the "photonic crystal fiber (*PCF*)" "surface plasmon resonance (*SPR*)" biosensor is presented in this work. The sensor is designed in a manner that it can develop eight cores. The sensor can detect analytes, chemicals, heavy metals embedded water samples, water samples, etc. The metal deposition technique at the outer end of the *PCF* is used in the "proposed sensor design" to deposit plasmonic material. Sensor parameters are calculated in terms of "wavelength sensitivity," "amplitude sensitivity," "sensor resolution," "linear relationship between refractive index and resonance wavelength." Finally, the designed sensor has presented reasonable sensing parameters better than the reported sensors in recent times.**

Keywords: **"photonic crystal fiber"; "surface plasmon resonance"; "wavelength sensitivity," "amplitude sensitivity," "sensor resolution."**

I. INTRODUCTION

"Photonics crystal fiber (*PCF*)" is an exciting platform used to build surface plasmon resonance (*SPR*) based biosensors [1]. The main advantage of these sensors is they require a small amount of analyte for detection purposes. These analytes or chemicals are identified based on their refractive index values. Thus it can be assumed that any liquid can be specified and detected from the biosensor. But these biosensors work in a particular range of the refractive index. These biosensors are designed using three different methodologies like "internal metal deposition (*IMD*)", "external metal deposition (*EMD*)" and on "*D* shaped fiber" [2]. Every design methodology has its pro and cons, but *EMD* based fibers are easy to fabricate. Thus this technique is preferred over other methods of *PCF SPR* sensor designing.

The detection ability of the *PCF SPR* sensor is calculated using sensing parameters like "wavelength sensitivity (*WS*)," "amplitude sensitivity (*AS*)," "sensor resolution (*SR*)" "linear relationship between resonance wavelength and refractive index." Besides, some more parameters like "full-wave half maximum (*FWHM*)" and "figure of merit (*FOM*)" also produce valuable information about the sensor detection ability.

Several scientists have developed *PCF* based *SPR* sensors for sensing a variety of analytes. Their sensors are different from conventional sensors based on various parameters like design, materials, sensing parameters, etc. Noticeably, work done by multiple scientists enlisting in the field of *PCF SPR* sensors is discussed as follows. Some of the excellent work done in the area of *PCF SPR* sensor is presented in these reviews.

Gao et al. [3] developed a *PCF SPR* sensor with only six air holes. They used a thin layer of gold (*Au*) over titanium dioxide TiO_2 as a plasmonic material. Their sensor can operate in the infrared region and obtain a resolution of 2.5×10^{-5} *RIU* for detecting aqueous analytes. *Hasan et al.* [4] developed a *PCF SPR* sensor having spiral geometrical structure. The plasmonic material used in their research is *Au*. Their designed sensor is able to detect various biological, chemical, and biomolecules analytes. *Yang et al.* [5] developed a *PCF SPR* sensor which exhibits strong birefringence behavior. They have used silver (*Ag*) coated over graphene layer as a plasmonic material through this sensor they have obtained a resolution of 3.97×10^{-5} *RIU*. *Dash et.al* [6] developed a *PCF SPR* sensor for refractive index sensing they have used aluminum-doped zinc oxide (*AZO*) as a "plasmonic material". They have obtained a high amplitude sensitivity of 167 RIU^{-1}. *Liu et.al* [7] designed a *PCF SPR* sensor to detect chemicals with lower refractive index varying from 1.00 *RIU* to 1.430 *RIU*. There designed sensor they have obtained wavelength sensitivity of 6300 nm/RIU. *Thenmozhi et.al* [8] developed a $D-$ shaped *PCF SPR* sensor having *Au* coating as a excitation material. This sensor performs very effectively under Infra-red region through this sensor they have obtained sensitivity of 50,000 nm/RIU and resolution of 2×10^{-6} *RIU*. *Dash et. al* [9] deigned a biosensor made up of "polymethyl methacrylate" they have used indium tin oxide (*ITO*) as a plasmonic material there presented biosensor gives sensitivity of 2000 nm/RIU and resolution of 5×10^{-5} *RIU*. *Rifat et.al* [10] designed a *PCF* based *SPR* biosensor for external analyte sensing they have used *Au* as a plasmonic material and obtained "wavelength sensitivity" of 4000 nm/RIU, "amplitude sensitivity" of 478 RIU^{-1} and "sensor resolution" of 2.5×10^{-5} *RIU*. *Hossain et al.* [11] developed a *PCF* based *SPR* sensor based on $D-$ shaped *PCF* though which various chemicals can be detected and investigated through the change in the refractive index value simultaneously. They have sensed the wavelength sensitivity of 15000 nm/RIU through their designed sensor and obtained the sensitivity of 6.66×10^{-6} *RIU*. *Sakib et al.* [12] presented a $DD-PCF-SPR$ biosensor to investigate analytes having refractive index values of *RI* 1.46, *RI* 1.47 and *RI* 1.48. Through their

Authorized licensed use limited to: Sant Longowal Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:19:37 UTC from IEEE Xplore. Restrictions apply.

AntMQoS: An Ant-based Multi-Constrained QoS Routing Protocol for Wireless Sensor Networks

Dilip Kumar, Tarunpreet Kaur

Abstract—**With the rapid development of microelectronics, wireless sensor networks (WSNs) have started to evolve into various applications that require complex operations, ranging from health care to multimedia transmission. However, successful deployment of resource-limited WSNs in such applications requires strict quality-of-service (QoS) constraints. This paper presents an ant-based multi-constrained QoS routing protocol (AntMQoS) for wireless sensor networks. It is a hierarchical routing protocol which takes independent routing decision to meet the application-specific QoS requirements (latency and reliability) of heterogeneous traffic generated by the source nodes. Simulation results reveal that AntMQoS performs better in terms of reliable data transmission, on-time data delivery, and energy efficiency to maximize the network lifetime..**

Index Terms— **Wireless sensor network (WSN); Quality-of-service (QoS); Ant colony optimization (ACO); End-to-end (E2E) delay; Residual energy; Routing protocol; Packet delivery ratio (PDR)**

I. Introduction

WIRELESS sensor network is a collection of small autonomous devices called sensor nodes deployed over geographical areas to monitor physical or environmental phenomena such as temperature, pressure, sound, vibrations, motion and seismic events at different locations. The construction of the sensor node mainly focuses on conserving energy, reducing cost and complexity, increasing flexibility, and providing robustness and fault tolerance [1].

The early research on WSN has mainly focused on monitoring applications, such as habitat and environmental monitoring, but with immense proliferation in micro-electromechanical systems (MEMS) along with large acceptance of wireless networking technologies have enabled widespread utilization of WSNs in different environments and for different purposes [2].

Manuscript received April 01, 2017, revised April 18, 2017

DK is with the Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, Punjab 148106 India (corresponding author to provide phone: +919417213652; e-mail: dilip.k78@gmail.com)

TK is with the Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, Punjab 148106 India (e-mail: tarunpreetkaur2468@gmail.com)

The new applications domains of WSNs have received some denominations in the literature. Sensor networks composed of smart sensor nodes used for transmitting video, audio, still images and scalar data in real-time and non-real-time may be called wireless multimedia sensor networks (WMSNs). Sensor networks deployed inside factories or industries used to monitor or control an industrial process termed as industrial wireless sensor networks (IWSNs). Sensor network composed of biomedical sensor nodes used for fostering health care applications termed as wireless body area networks (WBANs) [3-4]. These application domains generate diverse traffic which requires QoS assurance in terms of delay, reliability, energy efficiency, bandwidth utilization, jitter and throughput [5]. QoS guarantees in WSNs are a difficult and more challenging task to achieve due to the heterogeneous sensor nodes and the various applications domains running over these networks have different constraints in their nature and requirements [6].

Routing protocols have the ability to facilitate application-specific QoS requirements under multiple constraints such as bandwidth, delay, packet loss, hop count, and energy [7]. In multi-constrained QoS routing determining an optimal route that satisfies the multiple constraints has been proven to be NP-complete [8], because the optimization of one metric leads to deprivation of another. So there is need of designing and developing routing protocols which can focus more and more on multiple metrics. An ACO algorithm is essentially a system based on agents which simulate the natural behavior of ants to solve the various optimization problems.

This paper revisits the issue of QoS in WSNs to propose a new multi-constrained routing protocol (AntMQoS) that uses ACO to meet the application-specific QoS requirements of heterogeneous traffic generated by the source nodes. AntMQoS is a hierarchical routing protocol which takes independent routing decision by relying on three QoS metrics associated with the link: residual energy, end-to-end delay and packet loss ratio. It distributes the diverse traffic over multiple paths by estimating the quality of the path in order to reduce congestion and improves the network lifetime.

The rest of the paper is organized as follows: Section 2 presents the related work. The proposed protocol is described in section 3. Section 4 describes the performance analysis of protocol through simulation. Finally, section 6 concludes the paper.

ISBN: 978-988-14047-5-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

AntMQoS: An Ant-based Multi-Constrained QoS Routing Protocol for Wireless Sensor Networks

Dilip Kumar, Tarunpreet Kaur

Abstract—**With the rapid development of microelectronics, wireless sensor networks (WSNs) have started to evolve into various applications that require complex operations, ranging from health care to multimedia transmission. However, successful deployment of resource-limited WSNs in such applications requires strict quality-of-service (QoS) constraints. This paper presents an ant-based multi-constrained QoS routing protocol (AntMQoS) for wireless sensor networks. It is a hierarchical routing protocol which takes independent routing decision to meet the application-specific QoS requirements (latency and reliability) of heterogeneous traffic generated by the source nodes. Simulation results reveal that AntMQoS performs better in terms of reliable data transmission, on-time data delivery, and energy efficiency to maximize the network lifetime..**

Index Terms— **Wireless sensor network (WSN); Quality-of-service (QoS); Ant colony optimization (ACO); End-to-end (E2E) delay; Residual energy; Routing protocol; Packet delivery ratio (PDR)**

I. Introduction

WIRELESS sensor network is a collection of small autonomous devices called sensor nodes deployed over geographical areas to monitor physical or environmental phenomena such as temperature, pressure, sound, vibrations, motion and seismic events at different locations. The construction of the sensor node mainly focuses on conserving energy, reducing cost and complexity, increasing flexibility, and providing robustness and fault tolerance [1].

The early research on WSN has mainly focused on monitoring applications, such as habitat and environmental monitoring, but with immense proliferation in micro-electromechanical systems (MEMS) along with large acceptance of wireless networking technologies have enabled widespread utilization of WSNs in different environments and for different purposes [2].

Manuscript received April 01, 2017; revised April 18, 2017.

D.K. is with the Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, Punjab 148106 India (corresponding author to provide phone: +919417213652; e-mail:dilip.k78@gmail.com).

T.K. is with the Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur, Punjab 148106 India (e-mail:tarunpreetkaur2468@gmail.com).

The new applications domains of WSNs have received some denominations in the literature. Sensor networks composed of smart sensor nodes used for transmitting video, audio, still images and scalar data in real-time and non-real-time may be called wireless multimedia sensor networks (WMSNs). Sensor networks deployed inside factories or industries used to monitor or control an industrial process termed as industrial wireless sensor networks (IWSNs). Sensor network composed of biomedical sensor nodes used for fostering health care applications termed as wireless body area networks (WBANs) [3-4]. These application domains generate diverse traffic which requires QoS assurance in terms of delay, reliability, energy efficiency, bandwidth utilization, jitter and throughput [5]. QoS guarantees in WSNs are a difficult and more challenging task to achieve due to the heterogeneous sensor nodes and the various applications domains running over these networks have different constraints in their nature and requirements [6].

Routing protocols have the ability to facilitate application-specific QoS requirements under multiple constraints such as bandwidth, delay, packet loss, hop count, and energy [7]. In multi-constrained QoS routing determining an optimal route that satisfies the multiple constraints has been proven to be NP-complete [8], because the optimization of one metric leads to deprivation of another. So there is need of designing and developing routing protocols which can focus more and more on multiple metrics. An ACO algorithm is essentially a system based on agents which simulate the natural behavior of ants to solve the various optimization problems.

This paper revisits the issue of QoS in WSNs to propose a new multi-constrained routing protocol (AntMQoS) that uses ACO to meet the application-specific QoS requirements of heterogeneous traffic generated by the source nodes. AntMQoS is a hierarchical routing protocol which takes independent routing decision by relying on three QoS metrics associated with the link: residual energy, end-to-end delay and packet loss ratio. It distributes the diverse traffic over multiple paths by estimating the quality of the path in order to reduce congestion and improves the network lifetime.

The rest of the paper is organized as follows: Section 2 presents the related work. The proposed protocol is described in section 3. Section 4 describes the performance analysis of protocol through simulation. Finally, section 6 concludes the paper.

ISBN: 978-988-14047-5-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

ISBN 978-981-11-7861-0
Proceedings of 2018 the 8th International Workshop on Computer Science and Engineering (WCSE 2018)
Bangkok, 28-30 June, 2018, pp. 222-226
doi: 10.18178/wcse.2018.06.040

Adaptive TDMA Based QoS-Aware MAC protocol for Hierarchical Wireless Sensor Networks

Dilip Kumar [1+] and Tarunpreet Kaur[1]

[1] SLIET Longowal, Punjab, India

Abstract. This paper presents an adaptive time division multiple access based energy efficient medium access control (ATDMA-MAC) protocol to handle the variable traffic load while maintaining the quality of service (QoS) assurance for delay-sensitive applications. The ATDMA-MAC protocol dynamically allocates time slots to the sensor nodes based on their queue length information to achieve minimum latency for a wide range traffic load. Furthermore, the analytical model of energy consumption has derived to demonstrate the superiority of the ATDMA-MAC protocol. Simulation results show that the proposed ATDMA-MAC protocol sends more data against existing TDMA based MAC protocols with minimum transmission latency and energy consumption.

Keywords: wireless sensor networks, MAC, TDMA, latency, QoS

1. Introduction

In the past decade, wireless sensor networks (WSNs) have come across as one of the significant technologies which incorporate automatic sensing, processing, and wireless transmission into small electronic devices called sensor nodes [1]. The information received from the sensor nodes is transmitted to the base station for processing and analyzing [2]. The past research on WSN is mainly focussed towards the monitoring applications but due to the advancement in micro-electro-mechanical systems (MEMS), the wireless networking technologies enabled the widespread utilization of networks in different applications like healthcare, military surveillance, industrial automation, and smart cities [3]. However, in these delay-sensitive applications energy efficiency, latency, and reliability are the primary constraints and to handle real-time data traffic in WSN, end-to-end latency within an acceptable range is required. Many researchers have tried to address these constraints by introducing different medium access control (MAC) protocols [4-5].

Generally, MAC protocols divide into two basic categories: contention based and scheduled based protocols. In contention-based protocols, each sensor node contends to access the channel. However, when several neighbouring nodes try to access the channel simultaneously, then there may be a chance of collision among the sensor nodes. This, not only cause a delay in data delivery but also depletes the sensor nodes energy very quickly [6]. The existing contention based MAC protocols are SMAC [7], TMAC [8], and BMAC [9]. The scheduled protocols avoid the probability of collisions by allocating a separate time slot to each sensor node. TDMA [10-11] is the most commonly used scheduled based MAC protocol which assigns guaranteed time slot (GTS) to access the medium for data transmission. GTS allocation provides collision-free data transmission regardless of the dynamic traffic load, thereby guaranteeing high efficiency and low transmission delay. These observation motivate researchers to modify the TDMA based MAC protocols to enhance and provide QoS assurance for smart cities applications where loss or delay in data packets is intolerant. This paper presents an adaptive TDMA-based MAC (ATDMA-MAC) protocol to support variable data traffic in cluster-based WSNs. The key contributions of ATDMA-MAC are summarized below: (i) A novel TDMA frame structure comprises of control slots, announcement slot, and data transmission slots.

+ Corresponding author. Tel.: + 9417213652
E-mail address: dilip.k78@gmail.com.

A Quad-Band Monopole Antenna for GPS and RFID Applications

Nihar K Sahoo
Numeregion pvt. ltd
Pune, India
niharkantasahoo7@gmail.com

Swapnil Gaul
Numeregion pvt ltd.
Pune, India
support@numergion.com

Kuldip Singh
Dept. of ECE, SLIET
Punjab, India
kuldip1217@gmail.com

Malay Ranjan Tripathy
Dept. of ECE, Amity University
Noida, India
malay.amity@gmail.com

2021 IEEE International Conference on RFID Technology and Applications (RFID-TA) | 978-1-6654-2657-2/21/$31.00 ©2021 IEEE | DOI: 10.1109/RFID-TA53372.2021.9617302

Abstract— **In this work, a multiband microstrip-fed printed monopole antenna is introduced for RFID and GPS applications. This antenna resonates at the frequency ranges of 0.89-0.91 GHz, 1.5-1.7 GHz, 2.35-2.57 GHz, and 5.01-6.55 GHz. This paper simulated an antenna on a FR-4 dielectric substrate of size 80 x 40 x 1.6 mm³. This simulation is carried out using TaraNG time domain solver where return loss, phase, radiation pattern, VSWR, and antenna gain are analyzed.**

Keywords*— *GPS antenna, Microstrip-fed printed antenna, RFID

I. Introduction

Over the few years, Radio-frequency identification (RFID) technology has been involved in different applications such as identification, tracking, monitoring, and management etc. [1], [2]. Generally, an RFID system holds a transponder, a reader, and a data processing unit whereas the reader contains an antenna [2]. Several frequency bands of the EM spectrum such as LF, HF, UHF, 2.4 GHz, 5.8 GHz, and 24 GHz are assigned for this application. Many research has been done for single-band, dual-bands [3], and tri-bands [4]. There are distinct frequencies for RFID applications consigned in different countries [5]. As well, several frequencies are assigned for various applications. Therefore designing a multiband antenna should permit the incorporation of various modifications in a single base. In addition, there exist many research works on modelling of particular classes of antennas used for other applications. From the review of literature, it has been felt that, a single antenna can have multiple applications. In this paper, we tried to fill the existing gap. One of the latest choices for multiband applications is a printed monopole antenna. This antenna is quite recognized for its simple structures, good impedance matching, and compact size [3]. Multiband performance antennas can be modelled by implementing parasitic structures, defected ground structures, slots, using various radiating elements or by mended structures. The proposed model is a low thickness monopole antenna.

A quad-band antenna is designed for three RFID bands and one GPS band. One is UHF (0.9 GHz), which supports short range and low data transfer rate. The other two bands (2.4 GHz, 5.8 GHz) are high frequencies, which are suitable for high data transfer rates. The fourth band is at 1.6 GHz, which is suitable for GPS applications [6]. The proposed antenna contains a single layer of substrate, which permits a modification in the height of substrate by microstrip patch configuration [7]. The proposed dimensions of antenna is 80 x 40 x 1.6 mm³. This antenna achieves high gain and wide-band performance at higher frequency bands.

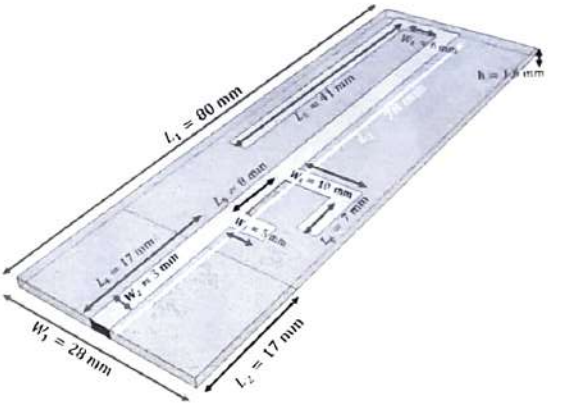


Fig. 1. Quad-band antenna

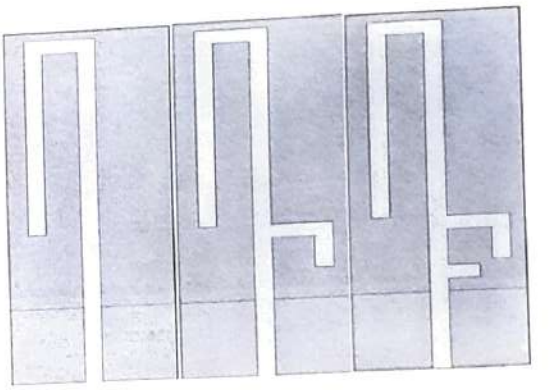


Fig. 2. Different stages of proposed model

The flow of this paper is ordered as follows. Section II defines the configuration proposed antenna with its three stages. Section III explicates the each stage results of antenna. It mainly explains the modification of antenna to create quad-band performance of antenna. In addition, it characterizes the S11, VSWR, radiation pattern, and gain of the proposed antenna. Section IV provides the conclusion of this study.

A. Analysis and Simulation Platform

The proposed model is simulated using TaraNG simulation software. TaraNG offers a solution to several electromagnetics problems with applications in Antenna Design, RADAR analysis, Microwave circuit design, Interconnect analysis, EMI/EMC, low-frequency electrostatics, and pulse propagation problems. For the analysis of antennas, different computational solvers are

Authorized licensed use limited to: Central Inst Of Eng & Tech. Downloaded on February 01,2023 at 06:21:29 UTC from IEEE Xplore. Restrictions apply.

A State-of-the-Art Study on Physical Unclonable Functions for Hardware Intrinsic Security

7

Vivek Harshey, S. K. Bansal, and Devendra Chack

Contents

DOI: 10.1201/9781003126645-7