A New Monopole Antenna Design for ISM Band Coverage

Ch.Sai Sree, B.Prudhvi Nadh, B.T.P.Madhav

Abstract— This paper proposes monopole antenna which is a wearable textile based model unites with an Artificial Magnetic Conductor (AMC) reflector. The suggested design entirely covers ISM (Industrial, Scientific, and Medical) band. Complete characteristics of AMC reflector have been analysed and produced effective radiation which is inclined for several wearable applications. In the design the space between the AMC reflector and antenna ground is changed up to which it radiates at multiple bands of frequencies. The presented prototype is fabricated on 40×20×0.5mm3 jeans substrate which has a dielectric constant of 1.6mm as its characteristics. Complete analysis of the design is showcased in various cases and in all the situations antenna holds its production. A systematic compact size, giant gain and radiation patterns builds prototype model of antenna a personage choice for wireless body area network communication.

Index Terms: PMC, AMC, ISM, Reflectors

1. INTRODUCTION

Wearable communication is one of the fast advanced fields of application-based research because of its applications in different fields. wearable antennas can be made of various fabric textiles which are applied to the human body[2] and considered as on-body mode[3].To apply the wearable technology, the designed antenna should be minimized and also should be implanted in various surfaces[4]. Under these circumstances there are several challenges for performing wearable communication system i.e.., on the antenna performance there is a deteriorating effect of human body. As due to the dispersive and lossy nature of the body tissues, the body of human can absorb very large amounts of electromagnetic power that is radiated from the antenna [1]. When the antennas are placed very close to human body radiation reduction and frequency-detuning issues arises [4]. Also an adverse biological effect arises when the electromagnetic power is absorbed by the human body. To reduce these effects there are some structures that separate the antenna from environment. Artificial magnetic conductors are prominently used in low profile antenna systems. By using several patterns on electric conductor backed dielectric substrate provides a Meta material structure [5]. AMC is a kind of Meta material which imitates the PMC (perfect magnetic conductor) which does not exists in nature [6].

In [7], they have presented a planar inverted-f structure which is presented in the dual band and wearable communication system is applied to it considering nylon as fabric. This EBG structure which is a general and basic structure designed in this paper is also implemented with the above structure. The designed antenna works at 2.4 and 5.8 GHz frequency. This structure produces many important characteristics like low SAR value, high gain, and these characteristics are primary for wireless body area network applications. This paper [8], contains a bow-tie shaped antenna which is included with a CPW (Coplanar waveguide) to reduce backward scattering wave in the human body. The substrate used here is polyethylene terephthalate. It operates at the frequency 2.4 and 5.8 GHz frequency. Here [9] presents a monopole patch antenna and it is isolated with EBG (Electromagnetic band gap) structure. This structure covers GSM (1.8GHz) and ISM (2.45GHz) bands and also the radiation of human body is also decreased over 15Db. Here the effect of frequency de-tuning over the human body is also decreased and several crumpling, bending and on-body conditions of an antenna are studied and presented to obtain the performance and also assessment of SAR (specific absorption rate) is also performed. In this paper [10] fractal antenna for satellite communications is designed with dual band is designed with FR-4 epoxy glass substrate. Here radiation pattern, reflection coefficient, gain and directivity. The designed antenna resonates at 4GHz and 5.9 GHz respectively. Considering [11] feeding network for aperture coupled wearable antennas is designed. Here probe feeding method in traditional based is avoided. This design is constructed on PCB producing Industrial, Scientific and Medical (ISM) applications with frequency 2.4-2.4835 GHz. It also produced high front to back ration and low cross polarization along with gain of 5.6dBi and efficiency with 47%. Taking paper [12] into view millimeter-wave antenna is developed and it is merged with electro-magnetic band gap (EBG) which is a self-similar window like structure. Here polyester fabric is used. It operates at the frequency range of 20-40GHz with the backward radiation reduction by 15dB. Here the combination of this CPW-EBG antenna shows it is not highly sensitive to human body proximity. Regarding [13], here a micro-strip antenna is designed which is combined with chess-board like AMC structure with frequency range of 13.4 -20.5GHz this is mainly implemented to have the radar cross section reduction. Investigating [14] I observed a dipole antenna which is integrated with artificial magnetic conductor (AMC). The substrate used here is Rogers 5880Duroid. The applications resulted here is in X band i.e.., near 9.454 GHz. Here efficiency, directivity and front to back ratio of the antenna are identified. Here in paper [15], T type resonator antenna is

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designed and it is merged with AMC (artificial magnetic conductor) which operates at ISM (industrial, scientific and medical) bands with frequency 2.4 GHz. In this paper latex is used as a substrate and parameters of antenna like return loss, radiation efficiency, frequency detuning, gain and SAR values are observed. Taking paper [16] into account, a circular ring-slot antenna is designed and also integrated with EBG (Electromagnetic Band Gap) structure. The defined antenna has bandwidth of 2.28- 2.64 GHz, and covers the applications like Industrial, Scientific and medical applications at 2.4 GHz. Front back ratio is measured and specific absorption rate value for 1g and 10g of tissues are measured. In this letter, I am designing a CPW (Co-Planar Waveguide) fed rectangular patch antenna and it is implemented with several fabric materials like jeans, cotton, polyester and wool and identifying the fabric that produces the maximum output compared to others. Following this, the antenna is integrated with various AMC structures to identify the maximum reduction in the specific absorption rate (SAR) and also to increase gain value and to improve antenna radiation characteristics with human body. Generally designed antenna operates at several frequencies i.e.., at 2.5 GHz, 4.1 GHz and 5.9 GHz.

2. ANTENNA BASIC DESIGN

Proposed antenna is acquired from the following iterations as described in figure 1 and the outcome is shown in figure 3. The Antenna has the dimensions of 57×32.1mm.This basic antenna design configuration is obtained depending on the design of (1) which is operated in the ISM band i.e.., 2.45GHz. Here the radiating element and feeding line which is CPW (coplanar waveguide) were designed at the similar side with the Pellon fabric and it is modified by several fabric materials like jeans, cotton polyester and wool. The primary design configuration is based on jeans substrate with thickness 1mm, dielectric constant εr =1 and loss tangent of tan δ=0.004. Furthermore, jeans shows flexible characteristics, low profile 0which indicates multiple layers to rule the thickness of the antenna substrate when it is conformal to the user's body. Here figure1, indicates the monopole antenna of fabricated prototype and also describes the dimensional values of the antenna.

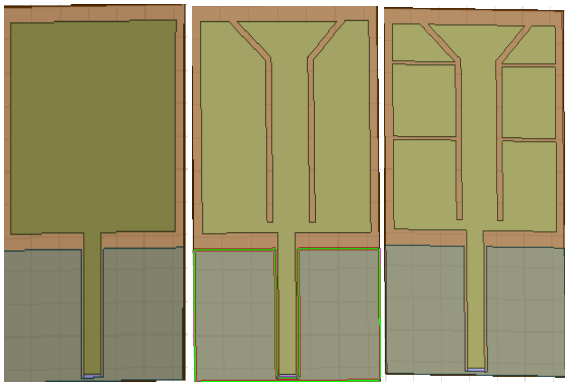

Fig1. Iterations for Variable antennas

3. DESIGN OF AMC REFLECTOR

Reflection phase characterization method was used to design AMC reflector. In a specific frequency band, AMC acts as a perfect conductor which produces in phase reflection characteristics. In this paper 2 different Artificial Magnetic Conductor's (AMC) are designed and these AMC's are integrated with monopole antenna. In the proposed monopole antenna design a Jeans AMC (4×2 array) is considered with dimensions of 24mm×25mm at a distance of 11 mm from the antenna.

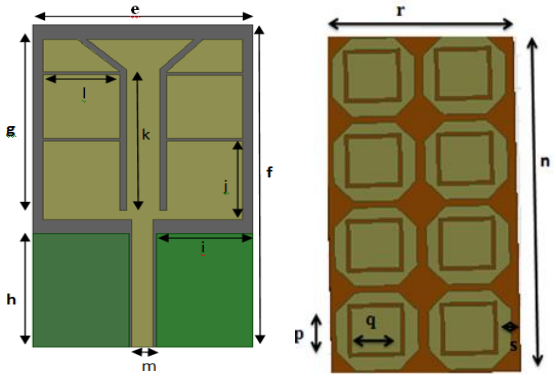

Fig2.AMC Reflector

Table1. Dimensions for the AMC antenna

Parameters	Value(mm)	Parameters	Value(mm)
e	32.1	l	11.2
f	57	m	3
g	32	n	104
h	20	p	12
I	14	q	17
J	14	r	57
k	24.98	s	4.3

4. RESULTS AND DISCUSSION

Iterations of AMC integrated antennas is mentioned out in the figure 3. Comparing the performance, first iteration output is obtained scarcely at 3 GHz and 5.65 GHz. Therefore second iteration is designed and it is produced at 3.05 GHz,5.6 GHz and 6.2 GHz respectively which is not considerable. So third iteration is performed which resulted the output at 2.4 GHz which certainly produces the applications that are not present till now. The designed antenna totally covers the entire medical and ISM band frequencies including wireless body centric application

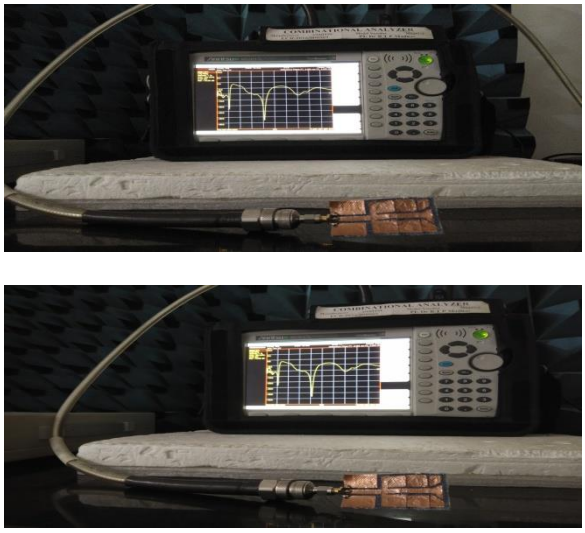

Fig3. Measured Results of Fabricated Antenna

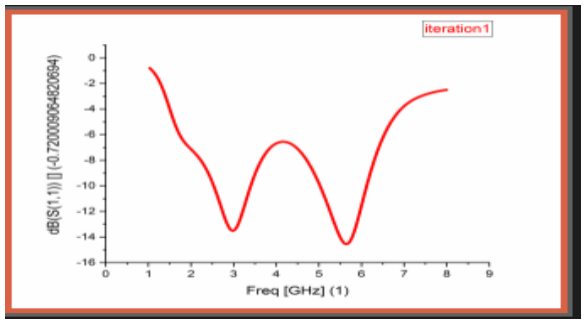

Fig4.Iteration1

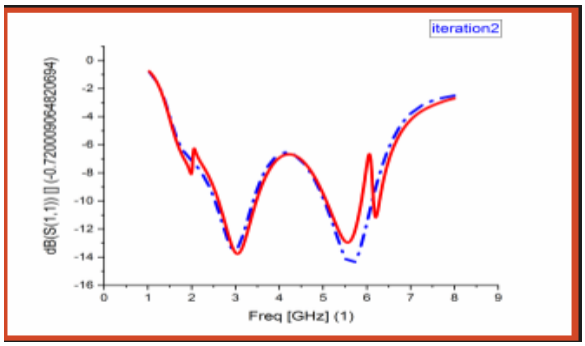

Fig5.Iteration2

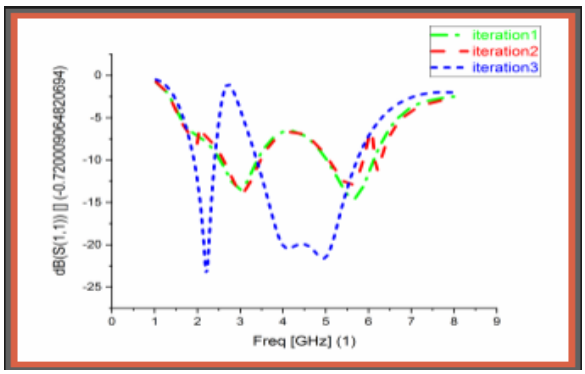

Fig6.Iteration3

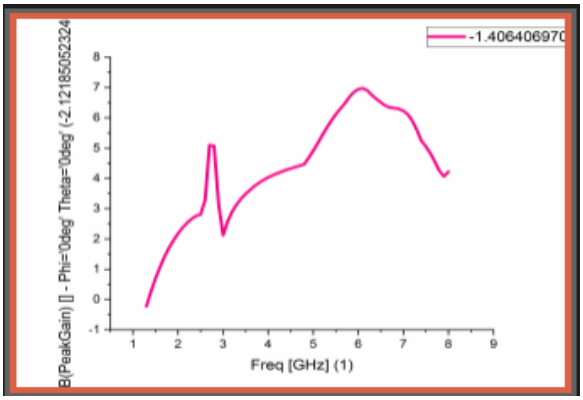

Fig7. Peak Gain Result

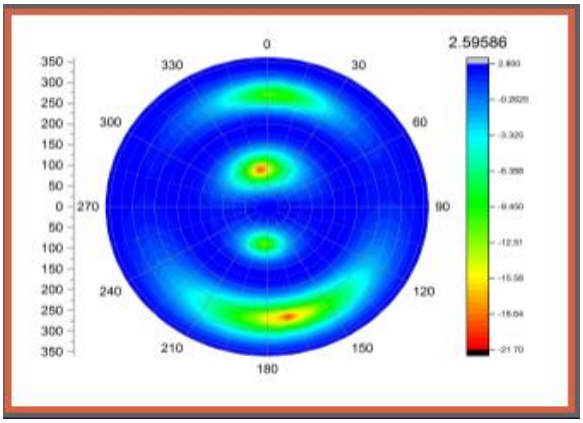

Fig8. Radiation Pattern

V.CONCLUSION

A flexible compact wearable antenna is manufactured and checked in this study. The dimensions of fabricated antenna are 57×32.1×1 mm3 which produced high gain at the applications of ISM band and resonates at multiple bands of frequencies. The proposed antenna is designed particularly for wireless body area networks which is a part of medical application. Future scope of the antenna can be introduced without any effects on the human body and also directly be interacted with human body to transmit signals and thereby to obtain readings from the human body.

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