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Some Studies on Wearable Printed Antennas

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ABSTRACT

The demand for wearable antenna is obvious for the development of different electronics gadgets. The present day human demands light, small, electronic equipment. The antenna being the heavy part of the communication system more research is going on the suitability of different antenna that a person can wear on his body or on the dress. In this paper the basic challenges of wearable antenna is addressed particularly the Microstrip printed antenna.

Key words: *Microstrip antenna, wearable antenna,* CAD

INTRODUCTION

In the recent years there are tremendous development of technology, particularly in the field of electronics, communication and computers. The present day human is dependent on large number of small communication devices like mobile to different types of sensors, including medical sensors. The dependent on electronic devices boost the efficiency and saves time to a greater extent. No advantage is left without disadvantage; on account of dependence on these technologies they are far away from physical exercise as a result they are susceptible to different life style disease like blood pressure, diabetics etc. On account of this, it is some time necessary to monitor the biological parameters of the body and to be recorded / transmitted to other equipment/doctor for analysis. This work is done by sensors and the data is transmitted through antenna to other devices or location. The wireless transmission of data takes place through an antenna which is known as wearable antenna [1-4].

The wearable antenna mainly faces different challenges.
(i) Human body absorbs Electromagnetic wave radiated from antenna when placed near the body, resulting reduction of antenna efficiency of wearable antenna.
(ii) The size and weight of the antenna should be small.
(iii) The Specific Absorption of the antenna should be taken into consideration, as the antenna will be touching/very near the human body.
(iv) The antenna technical specification changes as the curvature of the antenna changes therefore, it is to be analyzed thoroughly.

This paper addresses the use of Microstrip antenna [5-6] as wearable antenna and the challenges. The paper gives a brief introduction to Microstrip antenna with some CAD formulas and the results and conclusions are discussed.

MATERIALS AND METHODS

(i) Microstrip antenna as wearable antenna

Microstrip antennas [5] have emerged as potential radiators due to their many attractive features such as low profile, reduced weight, easily flush mounted, low manufacturing cost and polarization diversity. This has been one of the most rapidly developing topics for the last thirty years. Manufacturing antennas with features like light weight, low cost, low profile, multiband depends on the ability of the designer to precisely control the manufacturing process.

Searching of mathematical modeling will predict the practical antenna more accurately with less expense and hence enhances the Computer Aided Design techniques.

(ii) Microstrip Antenna Calculations

The steps involved for the design of microstrip patch radiator are as follows.
The resonant frequency of a rectangular patch antenna [5] of length L, width W and height h, dielectric constant of the dielectric ε_r in its dominant mode is given by.

$$f_r = \frac{c}{2L_{eff}\sqrt{\varepsilon_{reff}}} \quad (1)$$

Where,

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{1/2} \quad (2)$$

$$L_{eff} = L + 2\Delta l \quad (3)$$

$$\Delta l = 0.412h\frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{w}{h} + 0.8\right)} \quad (4)$$

L_{eff}: effective patch length (which is a function of L and h) .
ε_{reff}: effective dielectric constant considering the fringing field effects (which is also a function of L, h, and ε_r).

Designing an antenna particularly the wearable antenna requires the knowledge of electromagnetic properties [6-7] like permittivity, and loss tangent of the material used. General purpose Microstrip antenna is flat and designers will be interest in the measurements of gain, efficiency, return loss, radiation pattern. In case the antenna to be used as wearable antenna [1-4] the bending characteristics [8-9] is to be determined. The Specific Absorption Rate (SAR) of the antenna should be within the legal requirement for the health effect of radiation.

RESULTS AND DISCUSSION

The result depicted in figures (I-II) revels that the technical parameters associated with the antenna changes due to bending. The bending results reduction in the resonant length of the antenna and resonate frequency increases. There is no severe change in the parameters like input-impedance bandwidth and input-reflection coefficient (S11) at the resonant frequency due to bending.

Antenna bending radius taken here is given in table 1.

TABLE:I (Antenna bending radius)

Antenna No	1	2	3	4	5
1/(Bending radius) (mm^{-1})	0	0.0197	0.0157	0.0131	0.0112

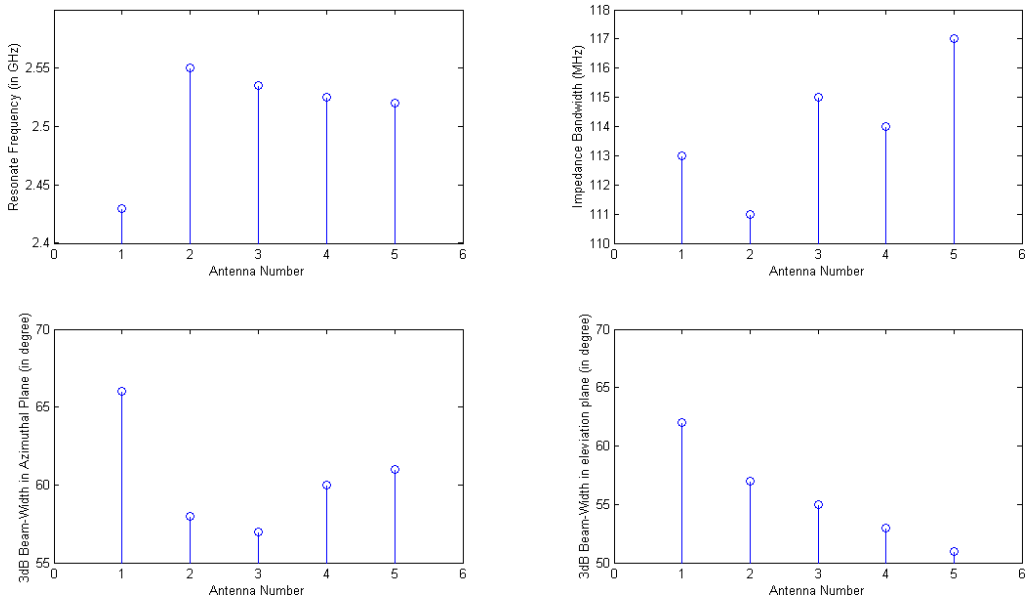

Figure I: Variation of different technical parameters like (Resonant frequency, Impedance bandwidth, 3dB Beam-width in Azimuthal plane, 3dB Beam-width in elevation plane) with respect to different antenna specified in table I.

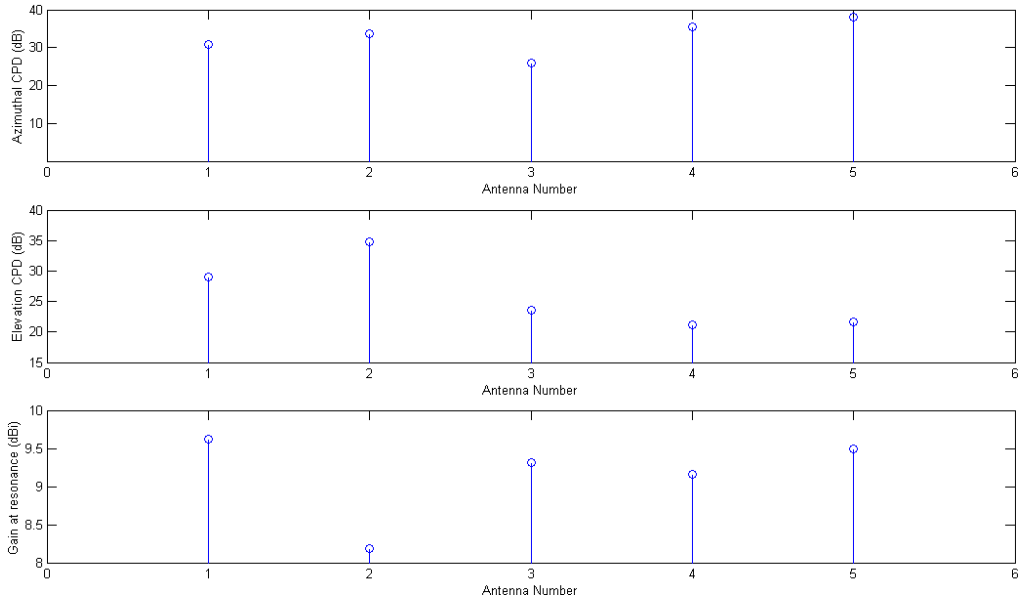

Figure II: Variation of different technical parameters like (Azimuthal Cross polar Discrimination, Elevation Cross polar Discrimination, Gain) with respect to different antenna specified in table I.

CONCLUSION

Microstrip / patch antenna is a suitable candidate for wearable applications, due to its salient compact features and it can be built using fabric substrate materials. The antenna discussed in this paper is easy to make them operate at different frequency range/band. The other standard techniques used for improving bandwidth, obtaining different polarization are valid for this wearable antenna. The interaction between the wearable antenna and the human body cannot be ruled out and it is open for further research.

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