International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 3 (2015) pp. 6189-6196

http://www.ripublication.com

Review on Performance of Soft Wear Antenna

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Abstract

Soft Wear antenna is an arrangement of Wearable and textile antenna properties which is flexible in two dimensions. Soft wear antenna serves as element of clothes and it should not affect the wearer by means of any radiation persevere in it. It is deliberate in such a way to perform in close propinquity to human body antenna substrate made of fabrics. Conventional antennas are not bendable. So there is a need for malleable textile materials. Textile material forms an interesting substrates permittivity of fabrics its thickness, patch shape, resistivity properties like stretching and compression should take in consideration.The design specification, the used material in substrate, and the material conductiveplane gives more information to design a wearable microstrip Antenna. This paper gives evidences about those for the design and development of textile antenna .Nowadays wireless technology has challenges to construct a device with compact size, lightweight, low profile and ease in its fabrication. a right choice for such type of antenna is a wearable microstrip patch antenna. This type of antenna uses textile substrate .Electromagnetic properties such as loss tangent, permittivity are the requirement to Design a soft wear antenna. It is well-known to use in wireless body area network (WBAN).Wireless Body centric communication is also possible in this Type which uses the frequency of Industrial,Scientific,Medicine meant by ISM band(2.45 GHz)

Keywords: Soft wear antenna, Substrate, permittivity, Fabrics, Textile Material,Microstrip Antenna.

INTRODUCTION

Wireless Technology Plays major role nowadays in most of all application like communication, sensors, and also in Bio medical application. Especially in biomedical a device with compact size and light weight is preferred. In such device bending is expected to occur due to the movement of human body in various circumstances .when the device communicating with human body, machine man interface taking place between them.

Communicating the data and sensing of signal is possible by clothing. The oppression between the communication system and integration of clothing is a new risen Technology nowadays [5,12].To meet this requirement an in expensive, low profile, light weight , easy to fabricate and should integrate radio frequency circuits are desirable[4].For body centric wireless application microstrip antenna is suited because of its advantages especially its compact size and ease of fabrication in this type of antenna radiation is at a 90 degree angle to the planar structure and are efficiently covered by their ground plane[3].An easily available and possible Textile material, which is universally used by human is used to design a soft wear antenna simply called as wearable antennas for body area Network(BAN).To Design a soft wear antenna an electric and electromagnetic properties are essential, Transmission line method gives an accurate characteristics of the electrical properties[1].Dielectric substrates uses ordinary textile fabrics.This Review paper focused on textile substrates which is known as soft substrates the dielectric fabrics used in wearable Antenna[13].Since soft wear antenna is a wearable one communication nodes on the body are often in near radiation field region.Therefore on body radio behaviour is strongly influenced by an antenna type.The Effect of the human body and an antenna operation in close proximity have been published by many researchers.Efficiency of the antenna and its input impedance affects the proximity of the body [14-15].The near field region of the EM wave generated by the antenna couples the human body in which the performance behaviour of the antenna changes.[15].

An overview of some features influence dielectrics, soft substrates in the antenna behaviour and patch in different geometric shapes gives the information to choose the soft substrates to design textile Antennas.

Structure of Textile Antenna

It is planar structure, flexible in 2D plane, consisting of a conducting element on the textile layer. Dielectric properties are the most dominant for the most textile antenna structure. Basically microstrip antenna is best suited for wearable application because of ease of integration, low cost, less weight, and working in microwave frequency.

It has a metallic resonant patch in any geometric shapes printed on a dielectric substrate which is fed with a line known to be a microstrip line with a ground plane on the other side, Patch is made up of copper or gold and any possible shape is suited for radiating purpose, and the ground plane made up of any conducting material. Also the feed lines and radiating patch are photo etched on the dielectric substrate [1].working frequency will be in the range of an ISM band as shown in figure 1.

Few Important Parameters in textile antenna is radiation pattern, which is a graphical representation, gives the property of antenna as a function of space co-ordinate. In this type of antenna polarisation is achieved. Describes the magnitude and direction of field vectors change in time also gives information about time variation of time harmonic field vectors at a given points. Differentgeometric shapes, different soft substrates, and different conducting materials are anticipated to design a textile soft wear antenna.

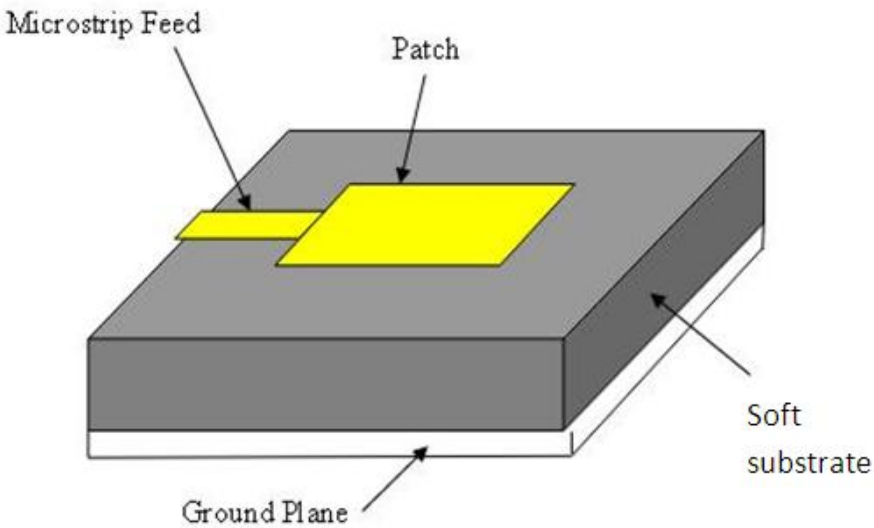


Figure 1. Soft wear Microstrip Antenna

Soft Wear Antenna Design concern

While connecting to the dielectric substrate geometrical shape of the patch should not change the dimensions. Mechanically it should be stabilized. So both are very important to preserve the antennacharacteristics. Also various connections by means of various techniques must not affect the electrical properties of the patch and the substrate such as substrate property and substrate resistivity. The radiating patch and the ground plane should be separated and kept constant to maintain electrical characteristics. If the conductive material detaches from one corner or the space between the metal layer varies the antenna resonant frequency changes. Same effect occurs when bending takes place in antenna [3].

Elastic Properties of soft textile materials

Stretching and compression varied due to dimension change in typical fabrics. Changes in substrate thickness leads to changes in resonant frequency as well as input impedance bandwidth .so design of fabric Antenna has a challenge to design a stable electrical characteristic and there should no influence on electromagnetic characteristics of the antenna. This shows elastic fabric should be avoided in wearable textile materials. This type of antenna is meant to wear. It could affect the resonance length of antenna. When it is embedding within clothing flat antenna surface will not provide any changes. Bending expected to occur[11].

Permittivity of Fabrics

Frequency, surface roughness, temperature, homogeneity of the material are the parameter 's' the dielectric permittivity depends on Relative permittivity real part defined by ε_r called dielectric constant but frequency is not constant in it. Whereas imaginary part defines loss tangent

$$\tan\delta = \varepsilon'' / \varepsilon' \qquad (10)$$

An isotropic material having different value when measured in different direction in textile material has been reviewed by many researchers. Also the characterisation depends on the orientation of electric field .Moisture content of the substrate changes the relative permittivity value which affects the bandwidth of the antenna.

Influence of Dielectric FabricThickness

Vernier Calliper can be used to measure the thickness of the Dielectricfabric. Thickness of the dielectric constant in substrate determines the performance such as bandwidth and efficiency in a planar [8] micro strip antenna. Very low dielectric constant improves the impedance bandwidth and reduces the surface wave losses. Dimension variation due to stretching and compression leads a strong influence on the characteristics of electromagnetic field.Resonant length variation The input impedance and resonant frequency determine by the thickness of the dielectric [1].Thickness in dielectric Fabric which influences bandwidth is related by its quality factor BW˜1/Q. Thus dielectric thickness is significant in antenna design. Flexible substrate usage leads to achieve low profile solution.

Influence of Different input Techniquesand Soft Substrate

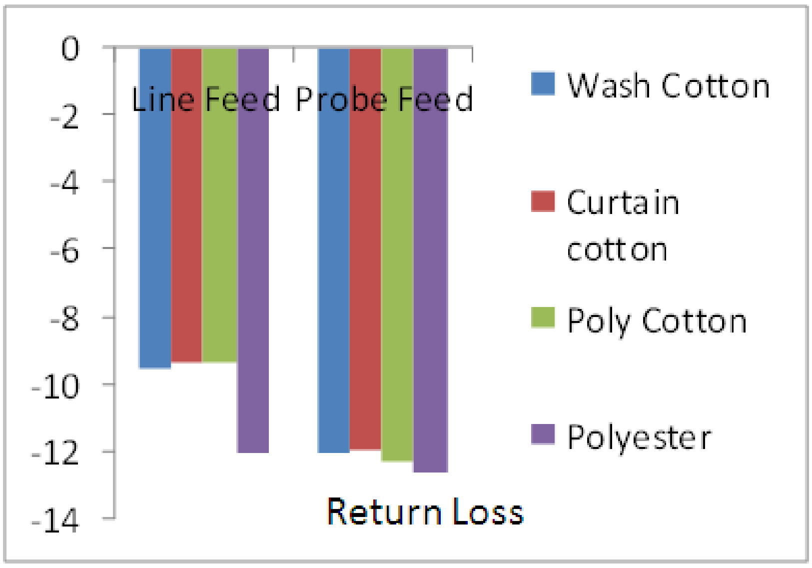
Thick substrate which is having low permittivity (value between 1&2) leads to large patch shape, whereas thin substrate with same dielectric constant leads to smaller patch [9].Different Patch shapes in various geometric shapes like rectangle, square, circle which leads to complex geometries varies in efficiency in antenna design.

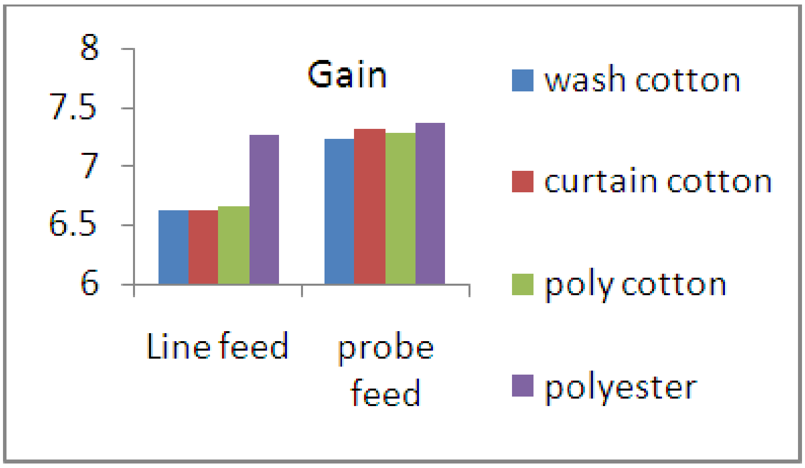
Designing an antenna substrate-related parameters are its thickness h, electrical permittivity ε_r its loss tangent tanδ.Soft textile substrates in wearable antennas are vellux, synthetic felt, Delinova 200, cordura, fleece, upholstery fabric. Textile materials used as substrates for wearable antenna categorize into two, namely natural and manmade fibers. Name of fiber‘s are trademarks of companies. Synthetic fibers few examples are polyamide, acrylic, polyester, polypropelene, Elastane, paramide [3]. Fabrics like nylon, cordura, coretex, dralon, fleece terylene, Dacron, ulstrene, Lycra, keviar are some of the fabrics used as soft substrates [3] in Textile antenna. Dacron is widely used polyester in textile materials. Fleece-Synthetic Woven polyester fabric felted on both sides soft and comfortable with skin. Fleece Fabric used for sports and leisure wear. Polyester Fibers which repels water rather than absorbing it. Hence dries very rapidly. Upholstery Fabric is a mixture of polyester and polyacryl. Three fabric layers bound together by bounding Wefts. It is woven. It is a choice for antenna design and does not bend as soft fleece so in bending condition while wearing it is not suitable. Vellux Hairy synthetic fabric in its centre covered from both sides with a thin layer of foam plastic, in which hair penetrates in to the foam, it has good insulating properties. It iselastic in both directions. Delinova 200 has Fluorocarbon impregnation coated with polyurethane, it is very hard and it is high Stretchable and has tear strength. Thus these types of soft substrates are of choice for the design and development of soft wearable microstrip antenna. Textile material thickness has influence on the antenna bandwidth. Hence Bandwidth is determined by the thickness of the substrate.

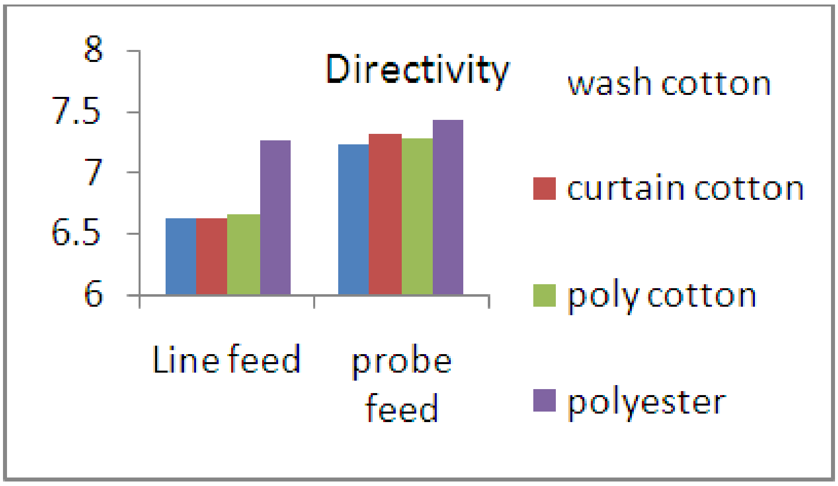
Complex permittivity of substrate value is an important electrical feature for selecting suitable materials and for the design of textile antenna. Performance of the antenna changes due to moistness which reduces resonant frequency when it is proximity to skin. Wearable antenna substrate is fabric like jeans, polyester, cotton. Patch, ground is conducting fabric like. Zelt, Shield it Flectron and Pure Copper Polyester Taffeta.

Table.1.Comparison of soft wear substrates with different techniques and its parameter

Parameters	Wash Cotton		Curtain Cotton		Poly Cotton		Polyester	
	Line feed	Probe feed	Line feed	Probe feed	Line feed	Probe feed	Line feed	Probe feed
Return Loss (dB)	-9.58	-12.09	-9.37	-12.01	- 9.40	-12.30	-12.1	-12.65
Gain (dB)	6.63	7.24	6.63	7.31	6.66	7.29	7.27	7.67
Directivity (dB)	8.76	8.71	8.74	8.77	8.77	8.75	8.80	8.85







Familiar Textile Materials like wash cotton,curtain cotton ,poly cotton, polyester,have been used in two different feed techniques and was compared in the above tabulation and Below chart shows the performance of the soft substrates in both input techniques.Observation shows in Line feed Technique polyester substrate shows the return loss as -12.1, which gives better performance than other substrates like wash cotton, curtaincotton, polycotton. Also it gives better results in terms of Gain and directivity.The Return loss of-12.65 is observed in probe feed. Gain and directivity which relates the efficiency of the antenna.

Electrical Surface Resistivity ofthe Conductive Fabrics

Electrical behaviour may be enumerated by the surface resistance and characterized by the surface resistivity. The surface resistance is the ratio of a DC voltage to the current flowing between electrodes of specific configuration that are in contact with the same face of the material under test. Its unit is (Ω), [13]. These fabrics should have a very low electrical surface resistance in order to minimize the electric losses and thus increase the antenna efficiency. Regardless of the fact that the surface resistance valueshould be constant over the area of the antenna [12]. The fabrics sometimes lead some heterogeneity, such as for instance some incoherence in the electric current. If the surface current is parallel to the discontinuities, then they will not interfere with the electromagnetic fields [13], but if discontinuities inhibit the flow of the electrical current, the fabric resistance increases [12]. Conductive spray technique a flexible technique in fabrication can be applied to textile material; in this a mixture of copper with gases under pressure can obtain a conductive layer [10].

Specific Absorption Rate

One of the key feature related to soft wear antenna design process is SAR meant by Specific absorption rate .Amount of heat generated in the tissue surrounding the implant softwear microstrip antenna as SAR in w/Kg.It is taken as an average value over a certain cubic volume of mass.Energy absorption in biological tissues is determined by the limitations for the maximum effective radiated power (ERP0 and the radiation efficiency of the softwear microstrip antenna in the body is utilized. Maximum SAR value directly dependent on the electric field from the antenna and also the size of the near field from it.Also SAR is considered as an index enumerates the rate of energy absorption in biological tissues.SAR variation depends on the antenna parameters such as gain and directivity.Efficiency and gain of an on body antenna canbe affected by three parameters like antenna distance from the body, antenna location on the body and also specifically antenna type.

Different human body models are usedto study the softwear antenna performance namely Torso, armetc. Torso model constructed using MRI image of real human body .This model shows the study of the performance of the antenna which is located on human chest ,arm, model which contains 2mm skin layer, Muscle and bone, it was modelled by assigning the conductivity and permittivity of different tissues in the human body[3]

Conclusion

Bandwidth performance and efficiency mainly depends on soft substrates used in textile antenna. Metallic SMA Connectors, micro strip feeding, coaxial probe feeding was employed commonly to feed the antenna. All textile antennas were usually excited by means of a 50 Ω coaxial SMA feed. The possibility of using textile materials for antenna design has been confirmed by uniting nonconductive textiles for substrate and conductive electro textiles for antenna patch and ground plane. This paper reviews about the inevitabilities in wearable microstrip antenna used nowadays in wireless Technology. Further research should focus more Challenging, thinner fabrics, also to improve body coupling performance with antenna structure. Moreover, future work will focus on the influence of clothing maintenance on the long-term behaviour of the antenna.

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