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Body Wearable Textile Antenna- A Survey

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Abstract

A body wearable antenna (BWA) is a hot topic for the research. In this paper various type of antennas are presented which are already available in literature. A BWA is a textile antenna, which is flexible and comfort. Sometime it is not necessary that space available for mounting the antenna is flat, so antenna should not change its characteristics during bending conditions. Rescue workers mostly work in such an environment which is severed by multipath, which cause the fading of received signal. So to avoid such type of problem a multi polarized antenna may require. Moreover when antenna is place over the human body, due to bidirectional properties of antenna backward radiation may harm the wearer's body. So to minimize such radiations EBG (Electromagnetic band gap) structures are used.

Keywords: Textile antenna, body wearable system, electro-textile, EBG (Electromagnetic band gap), SAR (specific absorption rate)

Introduction

WEARABLE antenna is an application-oriented and fast growing field in research. For sensing and processing purposes antenna may be integrated in garments which increase the security and comfort to the users. In this way, wearable antenna play very important role in wireless body area network (WBAN) [1]. These types of antennas provides the continuous information about the person's state of health by monitoring and transmitting the biosignals of that person. For this communication an antenna is required to transmit the signals. So instead of using a metal antenna a worn textile may be used as a transmitter or receiving antenna. The availability of conductive textile materials, known as electro-textiles [2]. The provided textile may not perform efficiently in the harsh environmental conditions in which firefighters often operate (i.e., high temperatures and/or high humidity). The close proximity of the human body to the antennas and the continuous deformation may change the dielectric constant of substrate which may further affect the radiation characteristics like radiation pattern, gain, VSWR and efficiency of the antenna [3]. Rescue workers mostly work in such an environment which is severed by multipath, which cause the fading of received signal. It can be minimized by using multiple polarizations at the transmitting and/or receiving side. Textile antennas previously proposed in literature already provide good performances. However, they possess a single-feed arrangement and consequently a single polarization which does not allow exploiting diversity [4] Because of its curved or other shapes, when an antenna have to place on body it is not necessary that space provided for it suits to antenna. So antenna should not change its properties when used for bending or crumpling conditions [5]. In a research it is found that when an antenna is loaded with EBG (electromagnetic band-gap) material, it helps to reduce in backward radiations, which are harmful to the body. By using this techniques SAR (specific absorption rate can be reduced) [6].

Literature Survey

First wearable antenna was presented by Salonen et al in 2001[7]. It was a planar inverted F antenna (FIFA) designed on unspecified substrate for dual band frequency at GSM (900 MHz) and Bluetooth (2.4 GHz) frequency band. In 2003 and 2004 they presented antenna designed on textile substrate for WLAN and GPS systems [8][9]. In 2006 Tornquo et al. designed a rectangular ring type antenna on fleece fabric substrate, where conductive part of antenna used was FlecTron*1*. This antenna works efficiently at 2.45 GHz frequency. It was integrated in garments and well tested for bending characteristics. In the same year Maciej Klemm et al designed a very small antenna of thickness 0.5 mm only, for wireless body area network (WBAN) applications [10][11].

In 2007, a dual-band coplanar patch antenna operated at the 2.45 and 5.8 GHz wireless bands integrated in electromagnetic band-gap material (EGB) was designed by Zhu and Langley. A thin felt is used as a dielectric substrate and Zelt fabric as a conductor for patch and ground plane. Thickness and dielectric constant for substrate used are 1.1 mm and 1.30 respectively with 0.02 loss tangent [12]. Calra Hertleer designed an aperture coupled antenna for integration into wearable textile system using the same material. Electrotextile used is copper plated nylon fabric with a surface resistivity of less than 0.1 ohm per square. For the path of this antenna they used the Shielditfabric due its good adhesive properties to paste on substrate [13].

In 2008 and 2009, Luigi Vallozzi, Hendrik Rogier and Carla Hertleer designed a dual polarized patch antenna used for ISM band (2.4-2.4835 GHz), wearable textile systems for rescue workers. This antenna is robust to channel fading and in addition, is completely integrable into protective garments. In 2009 Timothy F Kennedy et al designed an antenna for body-worn communication and navigation system used for 802.11 and 802.16 bands. Matthews and Pettitt presented three types of antenna i.e wire dipole, a bowtie and a spiral antenna, operating in frequencies from 100

MHz to 1 GHz. For design and fabrication of these antennas, good adhesive and conductive material is used, which are nylon and the copper coated fabrics. [14-17]

In 2010 Q. Bai and R. Langley designed a dual-band textile antenna under two-dimensional crumpling conditions. For design of this antenna a flexible felt substrate with a dielectric constant 1.38 and conducting 'Zelt' fabric was used for the conductors. Input impedance and radiation patterns analyzed at 2.45 and 5.8 GHz. Due to the crumpling the return loss of antenna is changed but radiation pattern remain in acceptable range. These are simple patch antenna and tested under flat as well curved condition. Luigi Vallozzi et al. designed a dual-polarized antenna for integration into protective clothing, such as firefighter suits. Substrate material used for this complete textile antenna is protective, water-repellent, fire-retardant foam, FlecTron and ShieldIt are used for ground plane and patch respectively [18-19]

In 2011 Declercq et al designed an aperture-coupled antenna on a textile and foam substrate, with a flexible solar cell, for tracking and monitoring purposes. LNA is used to improve the performance of antenna. But Zhu and Langley used an electromagnetic band gap for designing a dual band coplanar antenna to operate in 2.45 and 5.8 GHz wireless band. The purpose of using EBG is to reduce the body presence effect on performance of antenna [20][21].

In 2012 Juha Lilja et al [22]. designed a textile covered antenna which can be used in worse conditions like abrasion, saline water and varying climatic. Designed antenna was well tested and found suitable for GPS specifications. In the same year H.J. Lee, K.L. Ford and R.J. Langley [23] designed an aperture-coupled rectangular textile microstrip patch antenna which is mounted on textile stripline with a pin diode switching network. The felt fabric is used for because of its high flexibility and low loss. For the patch and ground plane a pure copper taffeta fabric with a conductivity of 5×10^6 S/m and a thickness of 0.08 mm has been used. The copper fabric is used because it is extremely flexible, mechanically robust and can be easily soldered. In 2012 Nacer Chahat et al. [24] also designed a textile Yagi–Uda antenna with an end-fire radiation pattern. It has been designed and fabricated using a commercial fabric. Reflection and radiation characteristics have been tested in free space and on a skin-equivalent phantom for on-body communications over the entire 57–64-GHz range. Scarpello, M.L et al. [25] designed stable, efficient and washable wearable antennas. These antennas are designed with combination of screen-printing and a breathable thermoplastic polyurethane (TPU) coating. This design does not change its performance when washed so many times.

Nurul Husna Mohd Rais et al [26]. designed a novel dual-band wearable textile antenna using the suspended plate concept. This antenna operates in both, ISM and Hiper LAN applications and was fabricated using conductive textiles. This design used slots, slits, and shorting posts to enable dual-band resonance and broad bandwidths in both frequency bands: 277 MHz (2.22–2.48 GHz) in the ISM and 850 MHz (4.95–5.80 GHz) in the Hiper LAN band.

In 2015 Jinpil Tak, and Jaehoon Choi, [27][28] designed a crossed LV-shaped logo (Louis Vuitton logo) an all-textile antenna to be operated in the industrial, scientific, and medical 2.45 and 4.5 GHz band. For the lower frequency band two longer thin arms are used and for the higher frequency band two shorter thick arms are used. For the fabrication of this antenna leather is used a substrate and conductive textile as a patch.

In 2016 Linda A.Yimdjo Poffelie et al. [29] designed an octagonally shaped UWB antenna (OSUA) coplanar waveguide CPW-fed antenna. When operating in proximity of a human body this antenna radiates bidirectional, and increases specific absorption rate. A full ground plane is directly added underneath the substrate layer as a reflector to avoid the effect of the human body on the antenna. A parasitic patch is also added beneath the radiating patch to enhance the bandwidth. This is remedied by using the concept of stacked patches.

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