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The Use of Conductive Threads in the Production of Experimental Textile Antennas

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This article describes the utilization of conductive threads suitable for production of experimental textile antennas for use in clothes and uniforms designated for rescue forces. The article also states reasons for choosing particular conductive materials from which the threads are produced, and which are suitable for production of antennas. Further, the construction of the experimental antenna made of an inox thread is described. The authors of the article also point out significant assets of textile antennas, which is for instance very low weight as against standard antennas.

1. Introduction

Nowadays, communication technologies penetrate into various areas of human activities. Communication devices consist of many components without which these devices could not work. For wireless information transmission one needs a technology capable of such transmission at a certain distance depending on a given application and bandwidth. The most important part of the quality of the wireless communication device is the antenna. The antenna is one of the most significant components as it dispatches and receives data. Therefore, it is crucial for every device that employs wireless communication based on the spread of electromagnetic waves. Recently, the so-called smart clothing has been widely discussed; such clothing has a large number of uses, ranging from army and fire brigade uniforms to the entertainment industry. At the same time smart clothing offers an interesting commercial potential for fashion of the 21st century [1].

However, the objective of this contribution is not a description of the overall concept of the smart clothing but the emphasis is being placed on the construction of textile antennas suitable for smart uniforms applicable to rescue forces [2]. The construction of the antennas designated for clothing is very different from standard antennas produced for instance by Printed Circuit Board (PCB) technology. This research is specific in the way it searches for the best materials for the construction of antennas designated for the following utilization in smart clothing [3].

Materials that can be used are required to undergo testing and their suitability or unsuitability for the particular construction of the antenna must be described. Every antenna can differ by its size and the type of material to be used. Above all, it differs

by the frequency for which the antenna is supposed to be designed. Passive textile antennas are constructionally and predominantly materially quite demanding. The advantage of the conductive threads is their flexibility and very low weight.

2. Problem Formulation

The fundamental prerequisite for the construction of the textile antenna is a good choice of suitable material. In this article the threads for antennas intended for the fire brigade and medical rescue forces are described. Rescue uniforms are sewn in such a way as to correspond with individual rescue forces and their regulations. The position of the antenna in the clothing should also be taken into consideration during the construction. The main requirements for the design of uniforms are raised directly by the rescuers themselves. If we are to compare designs of various uniforms and rescue suits we arrive at significant differences in weight.

The weight of a current fully equipped military uniform can exceed 20 kg, which is about the maximum allowed for action. The given weight also includes flashlights, batteries, transmitter, helmet and other necessary components. Some fire brigade and military gear can weigh up to 25 kg provided they contain special respiratory bottles. For such oversized uniforms every additional gram must be watched. Therefore, the emphasis is placed on the lightness of the uniform which can be influenced by the weight of the antenna in the transmitter or other communication devices although its weight is low compared to other parts of the uniform [4], [5], [8].

The goal is to save some weight in every component, which can be done by means of the textile antenna. The antenna must comply with the assumption of possible bending as it is to be sewn into the clothing. The most complex issue is to find good quality conductive materials suitable for the construction of the textile antennas [6], [7]. A vast majority of textiles and threads are not primarily intended for electrical transmission and thus their conductivity is unusable. Hence, the assessment of the conductivity of materials and threads by measurements is important.

2.1 The selection of the suitable material

The first stage should include the setting of parameters of the antenna. It is, therefore, necessary to know in advance the expected bandwidth in which the antenna is to work. The most significant part of this research is to examine characteristics of individual threads in order to determine their usefulness in the form of structures and curves through the various radio bands. Upon a detailed analysis of the conductive properties it is possible to decide on the further application of a particular type of treads. The first decision is made on the basis of the material composition of particular threads. If we are about to use the thread for creation of the textile antenna, we find the exact composition of the threads from the manufacturer’s data sheet [9].

Carbon and inox threads are potentially the most interesting materials for production of antennas. Both these types of thread are conductive and it is possible to employ them in various combinations and structures. The inox thread contains a yarn of stainless steel. In comparison with silver such a thread is much firmer and cheaper and it does not rust when in contact with water. Inox threads have a multitude of

benefits, for instance their corrosion and oxidation resistance. As water resistance and stability of the thread are very important for rescue forces, it can be used in production of antennas or other parts of smart uniforms [10], [11].

3. Problem Solution

A large number of communication devices use antennas created by PCB technology. As depicted in Fig.1 and Fig.2, the actual construction of the experimental antenna made of inox thread is based on the structure designs employed by the above mentioned PCB antennas. Provided we want to achieve comparable characteristics as those of standard antennas of transmitters, cell phones and GPS systems used by rescue forces, it is necessary to adjust the structure of the inox antenna in such a way that the requirements of the desired frequency band are met.

The choice of the base for the inox thread is not particularly limited. Not too heavy and not too thin textile cloth can be used. This applies to a part where the structure of inox thread is to be sewn. After a selection of the suitable conductive cloth the area where the antenna is to be placed is determined and then it is sewn by hand into a pre-drawn structure. Another possibility is to attach the inox thread to the fabric without sewing; however, this solution is not ideal as lots of adhesives behave as insulators.

The completed antenna is then, in laboratory conditions, connected to a source of different wavelengths while the extent of the signal emission and its strength is being tested. Textile antennas made of inox threads suitable for wearing on clothes or sewn into clothes offer a more convenient processing for wearing as opposed to standard antennas. Nevertheless, characteristics of pure copper or gilded antennas cannot be expected.

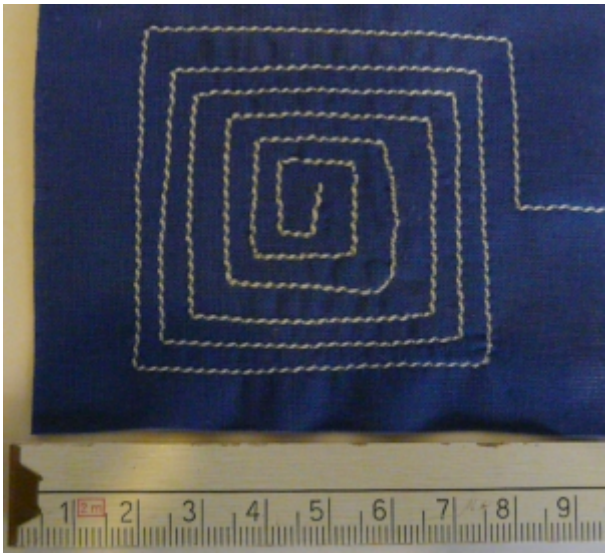

Fig.1. Textile antenna made from inox thread "square"

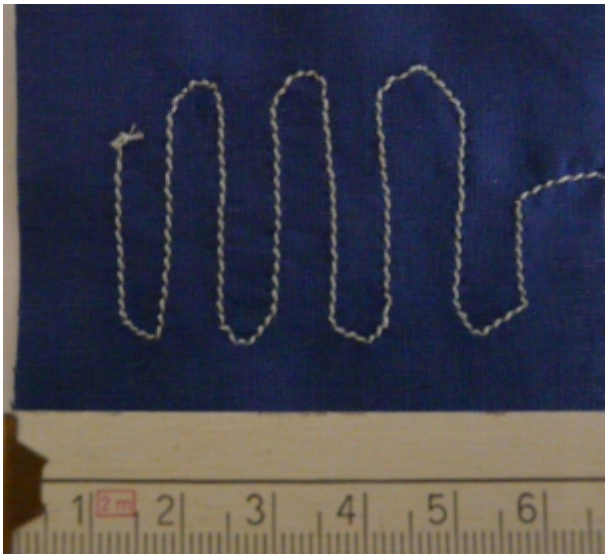

Fig.2. Textile antenna made from inox thread "wave"

4. Conclusion

The perfect and fully functional results relating to smart uniforms can be achieved only in cooperation with experts from the various fields. It is advisable for the experts who deal with smart uniforms to predominantly concentrate on their fields of expertise. Antennas are and will be an inseparable part of every modern apparatus and uniform of soldiers and rescuers. The main idea is to produce an applicable concept with the lowest possible weight, which is fulfilled as shown in Fig.1 and Fig.2. Antennas made of conductive inox threads can take their place in the development of smart uniforms. In the next phase of the research the design of the antenna and the structure for different types of frequency bands will be improved.

Acknowledgements

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