A Dual Band Belt Antenna

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1. Introduction

This paper presents an antenna structure design using a standard belt for wearable applications. The antenna arouse from a body of research work on wearable metallic structures functioning as antennas for wireless on-body networks.

Antennas have been developed for wearable applications mainly in the form of printed metal patches [1,2] using the textile material as dielectric substrate. More recently, the authors of the present manuscript have proposed the use of metallic button structures for the development of antennas for wearable applications [3-7]. Metallic button antennas have been designed to operate at the 2.4GHz and 5GHz WLAN bands in [3-6] and for UWB applications in [7]. These metallic button structures are able to operate on an on-body environment and present radiation patterns of multiband and wide band monopole antennas on a small ground plane.

This paper follows a similar research trend in the study of wearable metallic structures suitable for wireless on-body communications. In particular, a standard metallic belt buckle is employed to create an antenna embedded in a belt which is able to operate at the 2.4 GHz and 5GHz WLAN bands. The main advantage of belts over buttons is that belts are truly removable, and are able to carry computers or other electronics devices within them. In addition, the antenna structure on the belt buckle can be used either as a small wrist belt band or in the strap of a backpack or handbag. Antenna arraying and diversity could also be applied in the case of the two straps of a backpack.

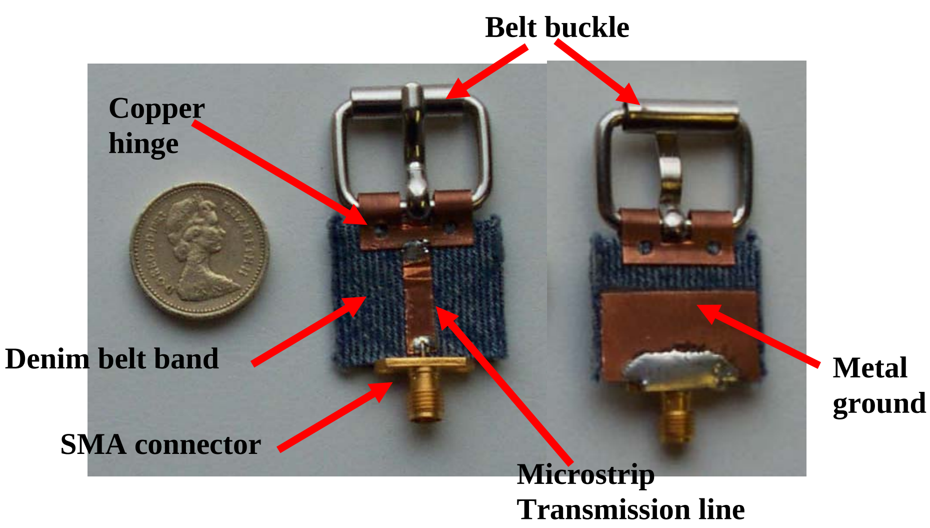
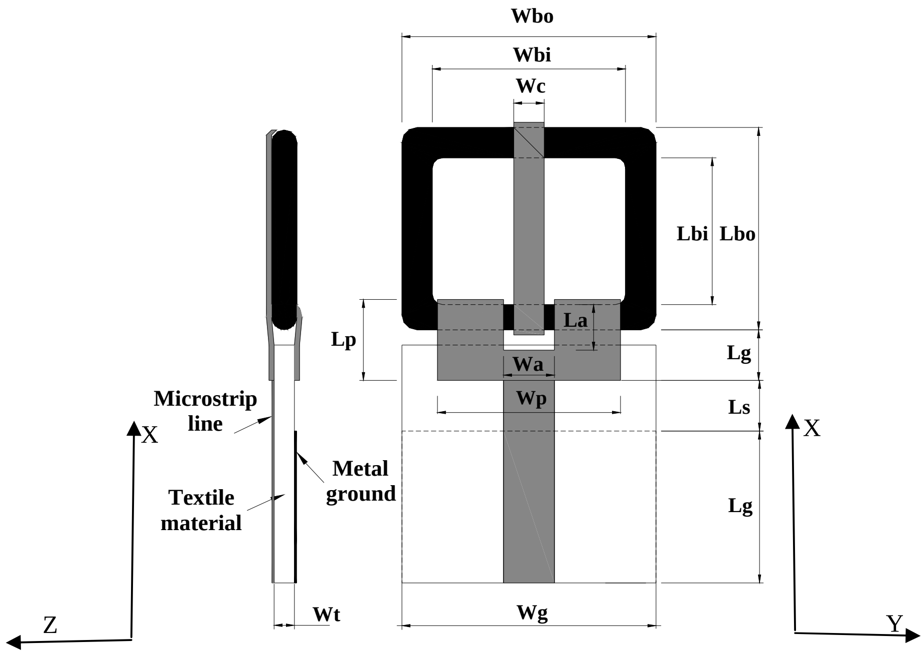


Fig.1. Photos of the belt antenna. Left: Front view; right: back view.

2. Antenna Design and Fabrication

The initial belt antenna consists of a standard metallic belt buckle, a denim band with the ground plane and a microstrip transmission line. The belt buckle is joined to the denim through a purposely made copper hinge which folds around one side of the buckle and clamps to the denim material on the other side. The copper hinge adds rigidity to the antenna and ensures electrical connection to the belt. A buckle of dimensions 25x20mm has been used as the radiating element of a first antenna design with total dimensions 25x45mm. An already characterized denim material of relative permittivity 1.4 was used as the main substrate for the belt, though other materials such as leather could also be employed. The antenna was fed by a microstrip transmission line which is connected to the 50ohm SMA connector on one side and to the radiating element on the other side. The ground plane of the antenna was calculated for optimum performance and placed on the other side of the textile substrate. The main dimensions of the antenna are shown in Fig.2 and Table 1.



Fig,.2. Belt antenna dimensions

TABLE I. Main dimensions of the belt antenna

Wg	Lg	Ls	Wp	Lp	Wa	La
25.0	16.0	5.0	18.0	8.0	5.0	5.0
Wt	Wc	Lbo	Wbo	Lbi	Wbi	
1.5	3.0	20.0	25.0	14.0	19.0	

3. Results

The calculated and measured reflection coefficient curves (S11) for the belt antenna are given in Fig.3 which shows two bands of operation coinciding with Bluetooth/WLAN and IEEE 802.11 standards.

The measured -10dB bandwidth of the antenna on air were 22.8% and 9.4% at the 2.4GHz band 5.25 GHz band respectively. CST Microwave Studio^{TM} was used for the simulation of the belt antenna, which predicted well the dual frequency, wide band, operation.

The measured radiation patterns at 2.45 GHz and 5.25 GHz for the XY, YZ and XZ planes of the belt antenna are shown in Fig.4. The measured radiation patterns of the antenna are those of a planar monopole with small ground plane. The predicted gain was 2.8dBi at 2.45GHz and 4.5dBi at 5.25GHz. The measured gain did not fall below 1dBi across the band.

The design of the ground plane dimensions and the distance of the belt buckle of the antenna to the ground are critical to achieving the mutiband and broadband characteristics of the antenna.

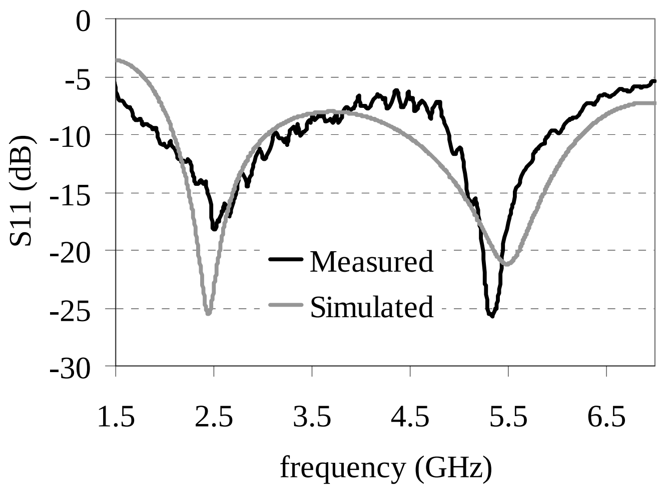


Fig.3. Reflection coefficient for the belt antenna

4. Conclusions

A novel wearable antenna for wireless communications is presented in this paper. This paper has discussed the possibility of employing a belt buckle as an antenna, bringing benefits such as removability and the ability to hand portable wireless devices from the belt itself. The antenna consists of a belt buckle, hinge, denim waist band and electrical connections. The antenna was fed by a microstrip transmission line on the denim substrate with the antenna placed on the other side of the textile band. The prototype achieves wide band, dual frequency operation and is able to cover the 2.45GHz and 5.25 GHz bands necessary for Bluetooth/WLAN and IEEE 802.11 standards.

Acknowledgments

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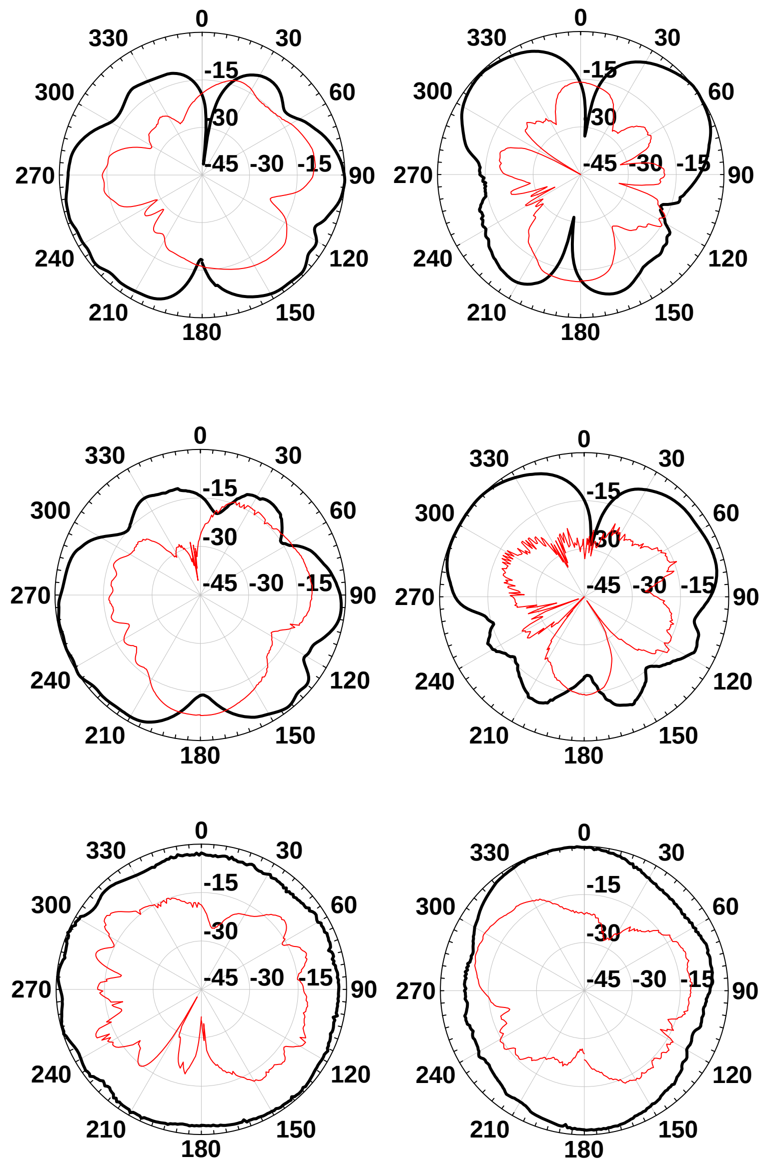

Fig.4. Measured radiation patterns at 2.45 GHz (left column) and 5.25 GHz (right column) of the belt antenna in air. XY plane (top row), XZ plane (middle row), YZ plane (bottom row).

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