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Ultra wide band slot dipole antenna performance measurements effected by male and female body

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Abstract— A one-sided directional ultra wide band slot dipole antenna with floating metal layer on the bottom side was presented and used for a body area network (BAN) measurements and influence of male and female bodies on the antenna performance was compared and discussed, The return loss (S11) curves are presented and discussed on various locations on the male and female body to clarify the difference of male and female body effect on the antenna performance

Index Terms— Body area network (BAN), slot dipole antenna, measurements, body effect on antenna, Ultra wide band antenna, UWB antenna

1 INTRODUCTION

A one-sided directional ultra wide band (UWB) slot dipole antenna with floating metal layer on the bottom side was designed, this antenna was chosen because of its compatibility with body area network requirements.

the characteristics of the omni-directional antennas are remarkably distinguished by its floating metal layer on the bottom side, making it a one-sided directivity ultra wide band, with a floating metal bottom layer which reduces the electromagnetic field in the backward direction leading to have less effect on the body tissues, on the contrary if having the antenna without the floating metal bottom layer which will affect the body with the backward electromagnetic field making the floating metal layer a necessity in Body area network applications.

Radiation pattern is shown in Fig. 1 for the slot dipole antenna with out the floating metal bottom layer and Fig 2. Shows the radiation pattern of the slot dipole antenna with the floating metal bottom layer, the difference can be seen easily between the two cases, in terms of shape, giving the advantage of using this antenna in the body area network project to have less interaction from the antenna on the body in the backwords direction when installed on the body.

The strong influence of the proximity of a human subject on the behavior of on body (body worn) antennas considering the frequency range for which the energy dose not penetrate deeply in the body appears significantly different in the UWB and narrow band case, in the UWB, case the proximity of the body generally improves the matching often increasing the bandwidth, because of two reasons: first is that losses favor the matching (lowering the S11 amplitude more or less as a whole), second, the high permittivity of the human tissues acting as sort of additional substrate specifically for tangential antennas without “screening isolation” the band will be shifted down.[1],[2].

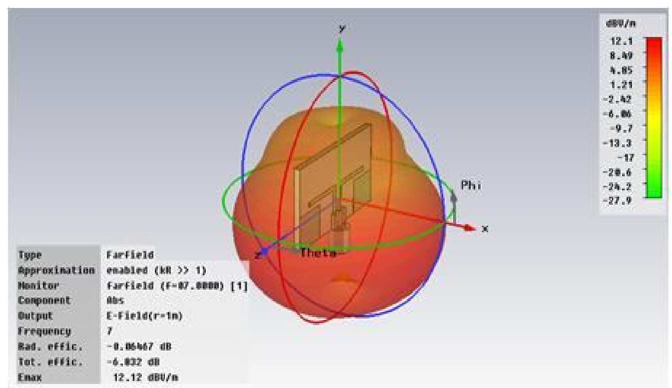

Fig. 1 Radiation patteren of slot dipole antenna with out the floating metal bottom layer

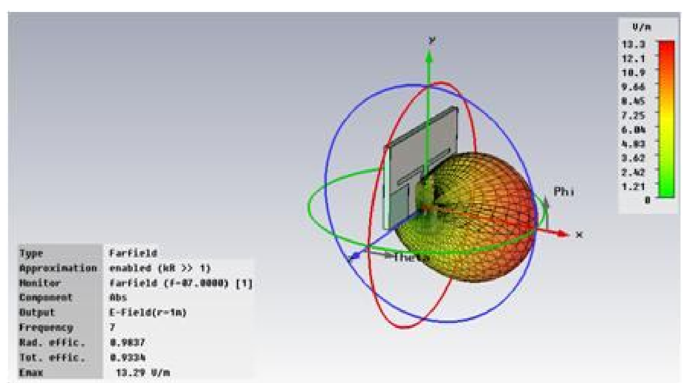

Fig. 2 Radiation patteren of slot dipole antenna with the floating metal bottom layer

2 ANTENNA DESIGN AND SIMULATION

The UWB slot dipole antenna was presented and designed in 2007 by Kanaya [3] with a coplanar waveguide (CPW) feed in the frequency range (7.25GHz-10.25GHz). A similar simulation and design was done in the frequency range of (6.25GHz-8.6GHz) the antenna dimensions were 34.5X18.6mm printed on a board with dielectric constant $\varepsilon r=4.3$, the thickness of the dielectric substrate and metal layer with conductivity of 5.8 x

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10^7 S/m, was 1.6 mm and 35 μm, respectively. Fig. 3 shows the layout of the simulated slot dipole antenna design, and Fig. 4 shows the implemented antenna picture.

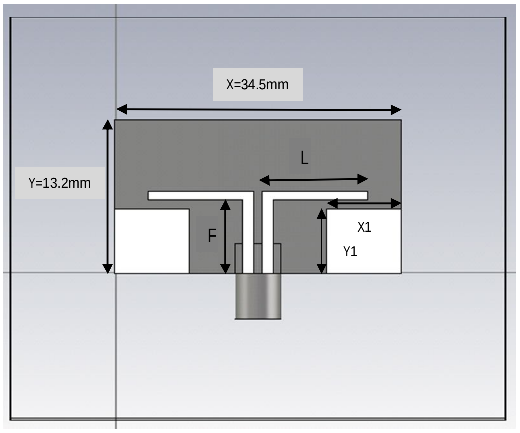

Fig. 3 Layout of designed and slot dipole antenna

Where, F=8.85 L=13.2 X 1=9 Y1=7.75

The effect of X1 and Y1 dimensions were on improving the performance of the dipole antenna, X1 was adjusted to give 50 ohms input impedance at resonant frequency and adjustment of Y1 gave a better broad frequency band.

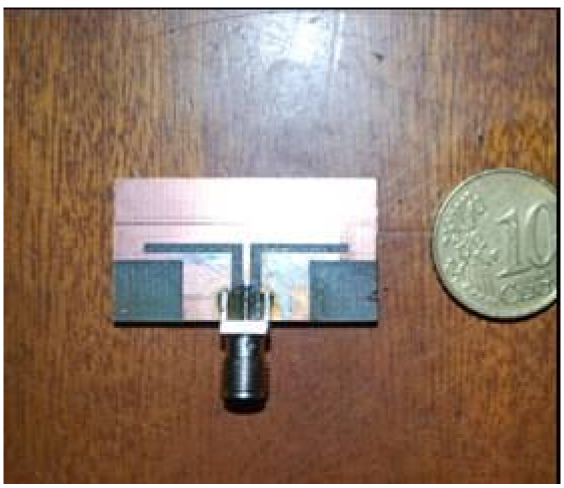
Fig. 4 implemented slot dipole antenna

Two identical slot dipole antennas were implemented A and B to get the best accuracy, Fig. 5. Showes the return loss S11 of the implemented A and B compared to the simulated blue curve in the isolated case (with out the effect of the body), as can be seen there is a shift in the frequency band due to manufacturing

2 Antenna Measurements

Preliminary measurements were performed at the Electrical Engineering laboratory on a male body of 58 Kgm weight and 160cm tall and a female of 57Kgm weight and 158cm tall to investigate the effect of gender difference on the performance of the ultra wide band slot dipole antenna with the effect of the body.

The measurements were done by having the back metal layer of the antenna directly touching the body, no screening isola tion were used and ferrite beads were used on the measuring nodes

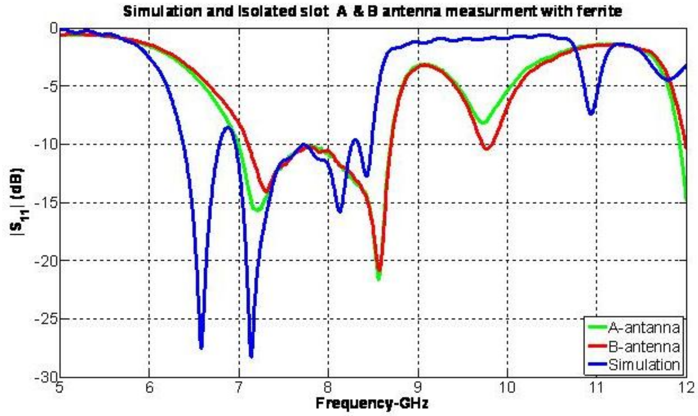

Fig. 5 Simulated and measured return loss for A and B implemented slot dipole antennas

Return loss S11 Measurements were done on different parts of the male and female body, first measurements were done on the right hip, and on two sides of the arm as shown in Fig. 6 which is indicated as upper and lower wrist posisions, Fig.7 shows the measured return loss S11 illustrating the difference in the antenna performance on the male and female hip and two arm locations, the doted curves represent the antenna return loss on the female body and the straight lined curves represent it on the male body.

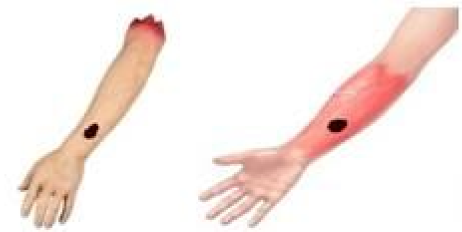
(a) (b)

Fig. 6 Position of measurements on the arm,(a) upper wrist, (b)lower wrist

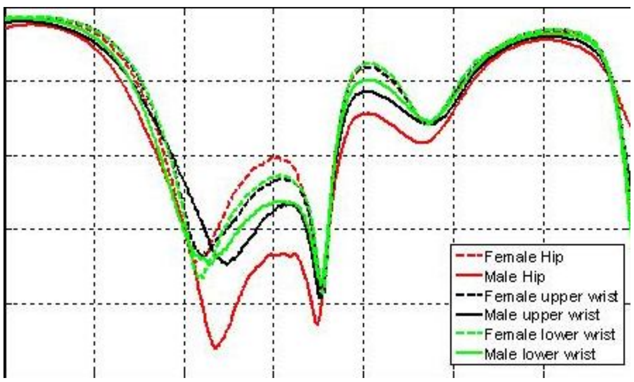

Fig.7 Measured return loss (S11) on male and female hip, upper and lower wrist positions

S11 measurements are shown in Fig 8. were done on the left chest taking five unlike positions, the five positions were chosen to form a horizontal straight line beginning from the middle of the sternum bone in the chest to the edge of the shoulder for both male and female, To have a better view on the difference of the male and female curves Fig.9 was drown to give the average values of the five positions for both genders

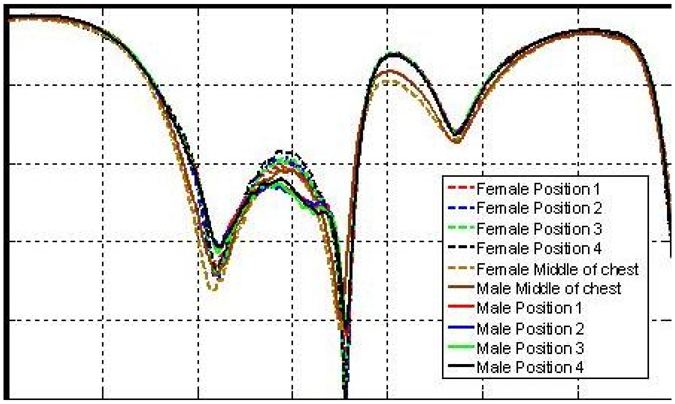

Fig. 8 Measured return loss (S11) on male and female in five positions on the left chest beginning from the middle of the sternum bone to the shoulder

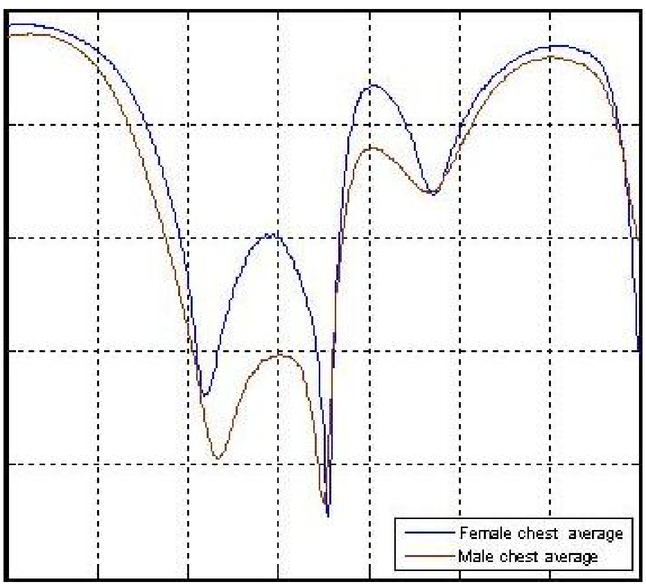

Fig. 9. Average of the five position return loss measured on male and female left chest,

3 Discussion

The deference between the UWB slot dipole antenna return loss measurements on a male and female body can be seen easily by comparing the previous curves, for the arm position measurements for both genders it can be shown that the male S11 cures have lower amplitudes along the whole frequency range and also is symmetrical with the female S11 performance curves giving better matching to the antenna than the female, in 8GHz the difference for both arm return loss measurements is about 2 dB between male and female while there is a difference of 7dB for the hip measurements, which can be considered due to physiology difference between both genders in that part of the body.

Comparison of the return loss S11 measurements for the five left chest position curve can be better seen in the average values shown in Fig. 9 that clearly illustrates a difference of 5dB at 8 GHz between male and female which can be due to physiology difference in the chest and also illustrates increasing improvement in matching of the slot antenna for the male body influence contrary to the female that made less antenna matching influence on the slot antennas

3 Conclusions

Male has better influence than female body on slot dipole antenna in terms of matching and the difference in return loss between the two genders vary depending on the part of the body that the antenna is worn on giving larger differences in the more physiology gender distinguished parts of the body

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4 References

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