Robust Wireless Communication Around the Body: Experiments Based on USRP Hardware

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INTRODUCTION

In this poster, we emphasize on robust wireless communication around the body in an environment full of static and dynamic obstacles. We report here some real-time experimental results, which we have obtained with the help of a universal software radio peripheral (USRP) test platform [4]. Our challenge is to improve this wireless transfer in a real-time environment, where lots of obstacles are present in surrounding including the human body, which may cause fading, scattering, and shadowing during the communication [1]. The technique we propose is relaying or introduction of two more on body nodes in between the two communicating nodes, which can reduce the effect of these factors and can make the communication less prone to errors. Mainly, we focus on signal-to-noise ratio (SNR) distribution indeed; SNR is a good indication of BER at receiver. Hence, during the experiments we compute the SNRs for single antenna (meaning no relaying) and for dual antenna (meaning relaying), furthermore by studying the statistics e.g. histogram or probability distribution function (PDF) of SNRs, we conclude that the relayed or dual link network works better than the single link.

SYSTEM MODEL AND SET-UP

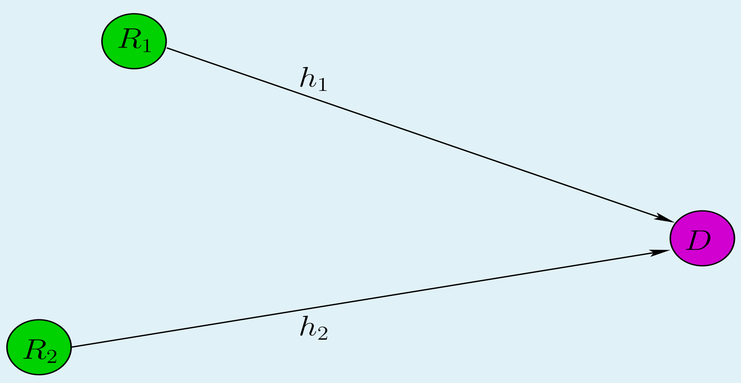

Fig.1: Relayed Network (System Model)

In Fig.1, h_1 and h_2 are wireless channels between on-body relays R_1, R_2 and destination D. These channels can suffer due to different types of fading: Rayleigh or Rician; however for our experiments we observed that the fading is Rayleigh. To decide the fading, the recorded statistics of SNRs have been processed and the Rician K factor has been estimated. As a result, we found that the K factor is always close to zero.

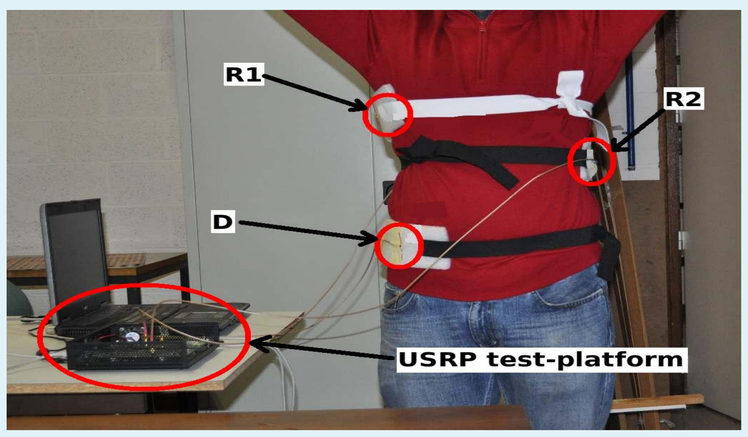

Fig.2: Real-time Experimental Set-up on USRP

Orthogonal frequency division multiplexing (OFDM) with Alamouti [2] [5] has been used to implement relayed network on USRP boards. Alamouti was helpful to arrange the OFDM symbols in space-dimension.

RESULTS

To prove space diversity or better dual-link communication, we need to compare the degree of freedom (DOF) of PDFs for both cases. Moreover, to justify the DOF, we compare experimental PDFs with central χ^2 distribution [6] as in Alamouti case the distribution for single antenna is χ^2 of DOF of 2 and for dual antenna, it is χ^2 of DOF 4, which indicates the cooperative diversity of order 2 [3].

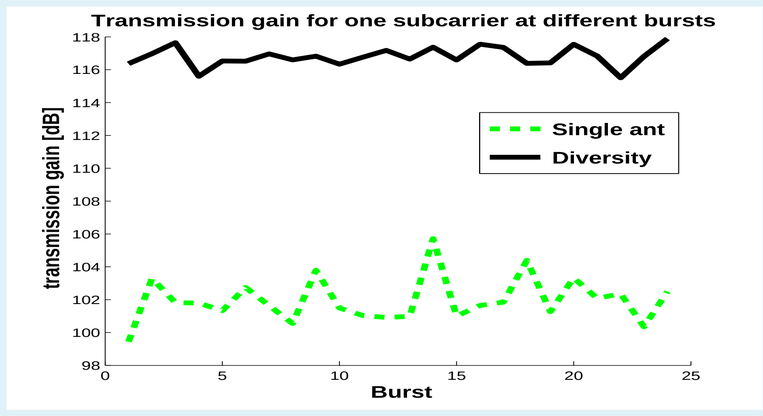

Fig.3(a)

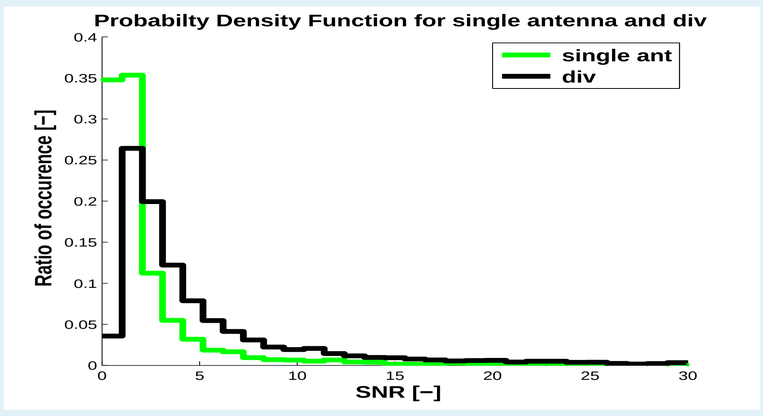

Fig.3(b)

Fig.3(a) shows the channel gains for both cases, where diversity channel is always stronger than other. Fig.3(b) shows the comparison of single antenna PDF with dual antenna PDF.

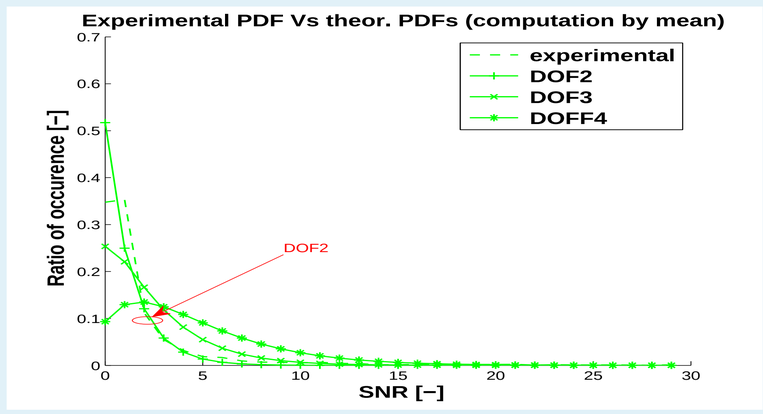

Fig.4(a)

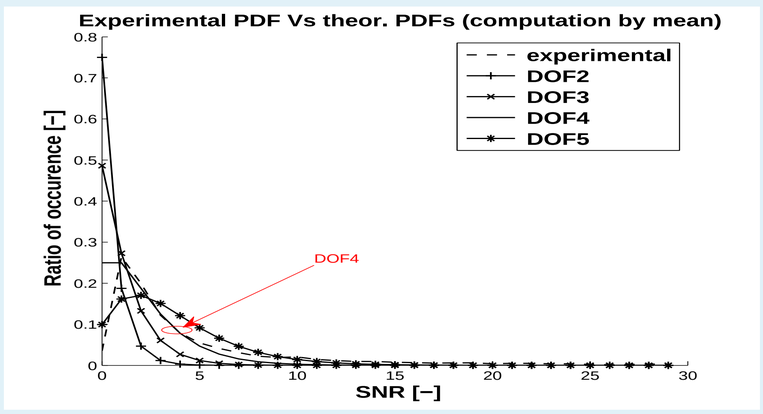

Fig.4(b)

Fig.4(a) & Fig.4(b) show the comparison of experimental PDFs with different χ^2 PDFs of different DOF for both cases, provided that the χ^2 PDFs have been computed with the help of experimental mean. The comparison clearly indicates DOF 2 for single antenna case and DOF 4 for dual-antenna case.

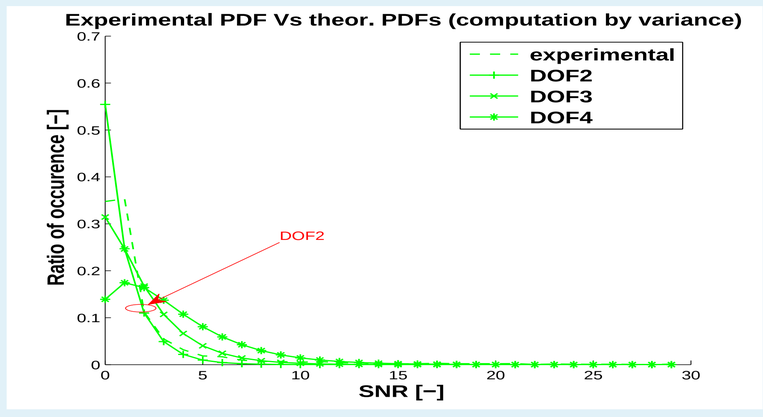

Fig.5(a)

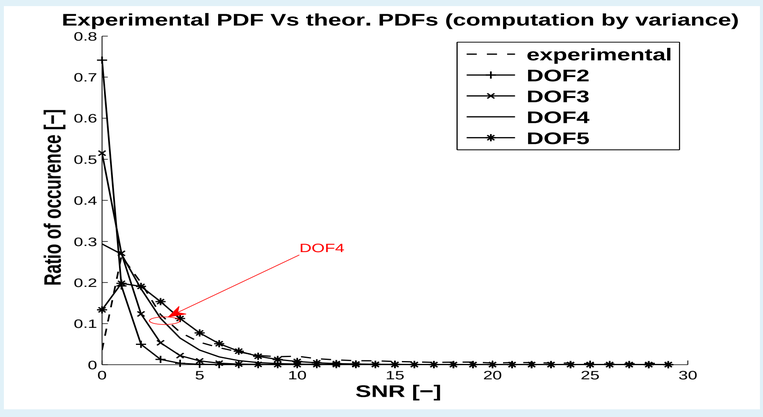

Fig.5(b)

Fig.5(a) shows comparison of experimental PDF with theoretically plotted χ^2 PDF of different DOF for single antenna & Fig.5(b) indicates the same comparison for dual antenna. Moreover, all the χ^2 PDFs have been computed with the help of experimental variance. Once again, single antenna PDF indicates DOF of 2, and dual-antenna PDF indicates DOF of 4, which exhibits order 2 diversity.

CONCLUSION

On the basis of the visual analysis made above, we can say that the USRP test-platform captured the diversity of order 2 successfully, which leads us to the fact that by using on body relays the effect of fading can be reduced in comparison of single antenna communication. The experiments can be continued further for different types of slow and fast fading environments. At last we can say that the results are interesting for medical practitioners, who are working on patient monitoring devices.

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ACKNOWLEDGEMENT

This work was supported by WALIBI project.