Wireless Channel Performance with Topological Antenna Diversity

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Key skills: *wireless systems, electromagnetics, signal processing, radio frequency techniques*

Background

Topological Antenna Diversity is achieved through exploitation of the Orbital Angular Momentum (OAM) of the transmitted electromagnetic wave. Topological diversity has recently been proposed as a great potential of improving the spectral efficiency (capacity) of radio transmissions [1]. OAM accounts for the phase front of the transmitted wave by providing independent phase states, thus, additional modes of propagation (degrees of freedom) resulting in independent simultaneous wireless radio links. OAM transmission has only very recently been applied to radio transmissions at much lower frequencies [1], [2], [3], [4] and, as such, these experiments raise as many questions as answers. For example, what aspects are fundamentally new? How can we best exploit this fascinating technique for realistic wireless systems? What are the benefits of OAM transmissions compared to multiple input-multiple output (MIMO) systems in terms of both simplicity and performance improvement?

Programme

The aim of this PhD is to thoroughly explore the emerging concept of topological diversity through OAM transmissions to determine what advantages it has and how it can be best exploited. This will encompass a scoping and feasibility study, as well as experimentation, and has the following milestones:

i. Report of prior art, including a scoping and feasibility study (6 months)
ii. Model OAM radio transmissions and submit the year 1 report (12 months)
iii. Investigate how OAM based radio can be exploited (24 months)
iv. Develop an experimental OAM system and test it (30 months)
vi. Investigate any further techniques that would advance the understanding of OAM radio, write and submit thesis (36 months)

Impact potential

The researcher is encouraged to publish in leading academic journals. Examples relevant to this programme of study are: IEEE Trans. Antennas and Propagation, IEEE Trans. Communications, IEEE Trans. Wireless Communications, IEEE Journals on Selected Areas of Communications, IET Communications, IET Microwaves, Antennas and Propagation.

The researcher is encouraged to develop exploitable outputs. Examples pertinent to this programme of study are: concept demonstration for use in attracting further investment and patenting of novel techniques.

References

[1] Tamburini F, Mari E, Sponselli A, Romanato F, Thidé B, Bianchini A, Romanato F, "Encoding many channels on the same frequency through radio vorticity: first experimental test", New Journal on Physics, 14 (2012), 17pp

[2] Tamburini F, Mari E, Thidé B, Barbieri C, Romanato F, "Experimental verification of photon angular momentum and vorticity with radio techniques", Applied Physics Letters, 99 (2012)

[3] Edfos O, Johansson A J, "Is orbital angular momentum (OAM) based radio communication an unexploited area?", IEEE Trans. Antennas and Propagation, Vol. 60, No. 2, Feb 2012

[4] Mohammadi S M, Daldorff L K S, Bergman E S, Karlsson R L, Thidé B, Forozesh K, Carozzi T D, Isham B, "Orbital angular momentum in radio – a system study", IEEE Trans. Antennas and Propagation, Vol. 58, No. 2, Feb 2012