Aalto University
School of Electrical
Engineering

School of Electrical Engineering
http://elec.aalto.fi/
Tel. 09 47001
Coordinator Marja Leppäharju

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New metamaterial. New applications.

Title	Wire media for broadband enhancement of radiation and power transfer
Content	The idea of metamaterials - artificial materials with useful properties not observable in natural media and chemically synthesized ones excites scientists almost two decades. Investigating metamaterials different methods and problems were suggested and solved leading to unexpected physical effects and applications. Current work is based on novel ideas and is finalized by results that seemed impossible or unpromising previously. Namely, we show that a class of metamaterial called wire media offers an efficient and broadband enhancement of radiation (from dipole or distributed sources) and broadband enhancement of electromagnetic energy transfer. The dissertation answers three main questions. The first one refers to an aperiodic but regular sample of wire medium called wire-medium hyperlens. Can it be used for overcoming the blackbody limit of thermal radiation in a wide frequency range and if yes, how to correctly implement it? Corresponding parts of the thesis provides the investigation on how the divergence of metal wires and other design parameters modifies the radiated power of a dipole. The second question is as follows: can a wire-medium slab with parallel alignment of the wires efficiently transfers the electromagnetic power over the wide frequency band, and yes how to apply it? We show that two hollow waveguides into which the wire medium endoscope is slightly submerged serve an imitation of two media hosting the ends of the wires from both sides of the wire media slab. In this case, the wire medium enables the broadband power transfer. The third question is as follows: can a broadband enhancement of radiation be achieved without enlargement of the radiating aperture? A novel metamaterial offering this enhancement is an irregular wire medium with small random tilts of wires.
Field of research	Radio Engineering
Doctoral candidate	Sergei Kosulnikov, MSc. Born in USSR, 1989
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Opponent	Professor Mikhail Lapine, University of Technology Sydney, Australia
Supervisor	Professor Constantin Simovski, Aalto University School of Electrical Engineering, Department of Electronics and Nanoengineering Professor Pavel Belov, ITMO University, Russia
Dissertation website	https://aaltodoc.aalto.fi/handle/123456789/53
Contact information	Sergei Kosulnikov, +358465539532, sergei.2.kosulnikov@aalto.fi P.O. Box 15500, 00076 Aalto, Finland

The dissertation is publicly available on the notice board of the Aalto University Learning Hub Atrium, Maarintie 8.