Introduction
We present the concept and electromagnetic aspects of Hypersurfaces (HFSs), artificial, ultra-thin structures with software controlled electromagnetic properties. The HFSs key unit is the metasurface, a plane designed with subwavelength features whose electromagnetic response can be tuned via voltage-controlled continuously-tunable electrical elements that provide local control of the complex surface impedance and advanced functionalities, such as tunable perfect absorption and wavefront manipulation. A nano-network of controllers enables software defined HFSs control related to the emerging Internet of Things paradigm.

The Visorsurf project

Controller (chip intergration)
- Metasurface unit-cell: 2x2 metallic patch, metal-backed
- Chip: voltage-controlled microwave network (an IC) supplying the desired complex impedance values (both R and C) at its output ports
- Frequency band: 4-6 GHz
- Chip ports connected to unit-cell patches using through vias
- Via position is critical
- Chip "behind" the ground plane

Decoupling of metasurface & chip (design and operation)
- Continuous complex-impedance tuning
  - Chip = varistor (R) & varactor (C) fine-tuned by two voltages
  - Range limits: Frequency, dimensions, parasitics, fabrication technology

Global and local tuning
- Chip-network provides the same or different RC values in each unit-cell & local or global tuning of the metasurface response

Tunable Electromagnetic Functions
The response of the metasurface depends on the impinging wave, that is, frequency, polarization, angle of incidence; for a given wave it is adjusted by the controller chip to provide the requested electromagnetic function:
- Tunable perfect absorption for different incidence angles
- Tunable anomalous reflection
- Tunable scattering (focusing, beam splitting, etc)

HyperSurface software aspects
- Software-Defined Metasurfaces are structures whose properties can be programmatically controlled: Reprogrammed, adapted.
- Interfaces to computer
  - Integrated Controllers
  - External stimulus sensors
  - Network / Interconnections

Internet of Materials

Selected publications

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