Passive communications with time-varying metamaterials (Ramot)

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The coming years will see a revolution by connecting everything to anyone, and RFID and similar technologies, will lead this 300B$ USD industry and 50B connected devices. Examining existing RFID standards suggests that the leading standard, called EPC Gen 2, is a standard in the 900MHz frequency which allows hundreds of tags to be read simultaneously (TDM based), but with two key drawbacks: distance (few centimeters) and security (none).

Novel invention introduces a new generation of RF tags, showcasing substantial increases with relation to prominent performance factors, mainly detectability range (in meters scale) and security; Whilst decreasing cost!

The unique solution is based on metamaterials, both 2D & 3D composites, made of resonant elements. Electromagnetic properties of each element are tailored by its geometry and innovative time modulation. More broadly, material bodies with high scattering cross sections (visibility to electromagnetic waves) are desired in a broad range of applications, including radar detection (especially in a clutter), radio frequency identification & tagging as well as security in wireless communications. The invention demonstrates designs of arbitrary shaped bodies with extremely high scattering cross sections. Those resonant properties could be obtained at any frequency, up to 300GHz, and are reconfigurable with an external electromagnetic signal.

Metamaterials with dynamically tunable electromagnetic properties enable achieving high scattering cross sections that could be controlled in real time. A given geometry of a body could support multiple resonant responses at a given frequency for electromagnetic properties of constitutive materials demonstrating specific values - Such values can’t be achieved let alone dynamically tuned with existent natural materials.

Applications:

- Long distance battery assisted RFID tags: RFID technology of passive tags enables detection of such tags from relatively short distances (several meters for the most). Time-modulated scattering cross section together with the lock-in detection scheme enables significant reduction of environmental noised (multiple scattering, interfering signals, other) and, as the result, dramatic increase in the detectability range. Ranges of hundreds of meters could be achieved.
- Targets identification in a clutter: Multipath is one of the major problems in detecting targets in a clutter (e.g. car identification in a traffic jam). The invention proposes highly visible (for electromagnetic waves) tags, with specific electromagnetic properties, modulated in time. Aforementioned time modulation, specific per object, holds a unique signature, which is identified by a reader/radar, operating at lock-in detection mode.
- Faking radars (military-oriented applications): Emulating a motion of Doppler-based radars: Harmonic/chirp/other time modulation of scattering cross section of a radar-visible object emulates its motion on the radar screen; nevertheless - the object is static/moves with a different velocity in reality.
- Security in wireless communication channels via frequency hopping approach: Electromagnetic scatterers with time-dependent cross sections could offer additional security in wireless communication channels. For example, a specific function, used for time control over the cross

section, known only to approved participants, prevents/complicates eavesdropping attacks.

Advantages:

- A new approach for encoding and transmission of information
- Additional adv.
- Creating high visibility to electromagnetic waves at a desired frequency range
- Time modulation enables reduction of environmental noise - achieving superior detection performances.
- RFID Implementation specific adv.
- Detection range - leaping from best practice today of centimeters to meters scale.
- Security - from no security RFID tags today to ‘Embedded by design security’ for novel invention.
- Low manufacturing cost - applicable for mass usage scenarios.

Patent:

METHOD AND SYSTEM FOR CONTROLLING RADIATION SCATTERING

Application number 256411

Related Publications:

Super Scatterers Based on Artificial Localized Magnon Resonances, 23 Jan 2018

Dmitry Filonov, Andrey Shmidt, Amir Boag, Pavel Ginzburg

https://arxiv.org/abs/1802.01663

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