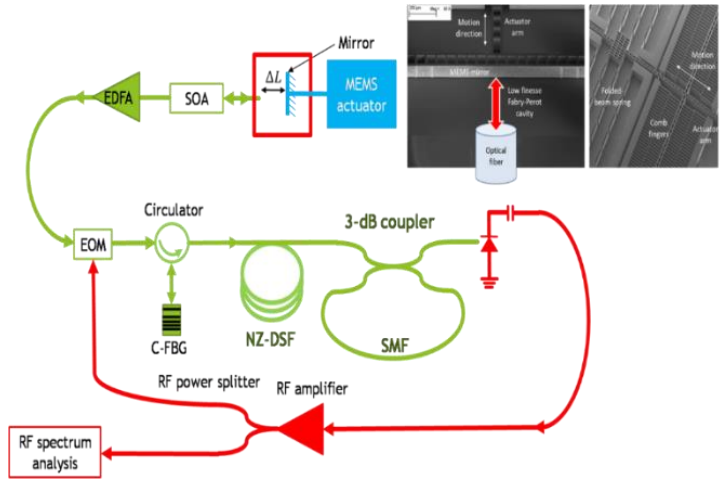
MEMS Based Configurable Microwave Photonic Filter and Optoelectronic Oscillator for Emerging 5G Networks

German University in Cairo (GUC)

A group of researchers in German University in Cairo, National Telecommunication Institute, Ain Shams University and Si-Ware Systems presented a novel technique to implement a wide tuning range microwave photonic filter and optoelectronic oscillator. “Microwave photonics (MWP) is a relatively new and promising field that provides functions in microwave engineering using photonic systems. The technology has very strong potential in emerging 5G networks covering its three working bands: low frequency band, mid frequency band and millimeter band” says Dr. Haitham Omran, associate professor in Electronics Department, GUC. This project combines the MWP technologies with the technology of Micro Electro Optical Mechanical Systems (MOEMS) for implementing a MEMS based optoelectronic oscillator. The proposed system provides solution for configurable microwave photonic filters and tunable optoelectronic oscillators for 5G networks. The tunability is accomplished using a micromirror driven by a comb-drive actuator fabricated by deep etching of silicon on insulator substrate.



The proposed system: MEMS based Optical Mechanical System (MOEMS)

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AutoAIDO: Automation of Analog IC Design and Optimization

Ain Shams University

Researchers at Ain Shams University have developed a software tool for the design automation of analog integrated circuit blocks. “Although analog blocks represent a small fraction of state-of-the-art integrated systems, they are usually the bottleneck in design time and effort. The reason is that mainstream analog design is still hand-crafted by expert human designers at the transistor level. Thus, there is a strong need for an analog automation tool that addresses the complexities of modern systems and the stringent time-to-market requirements,” says Prof. Hesham Omran, project principal investigator. “We developed an analog automation tool that can synthesize and optimize the key building blocks of analog design while taking variations and mismatch into account. Our solution has the same accuracy of industry-standard simulators but is orders-of-magnitude faster!” Hesham says.

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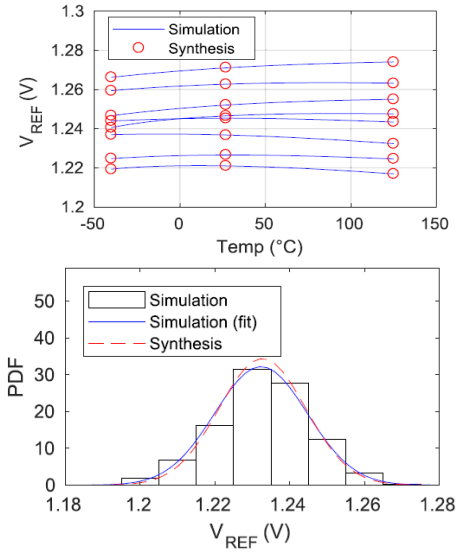
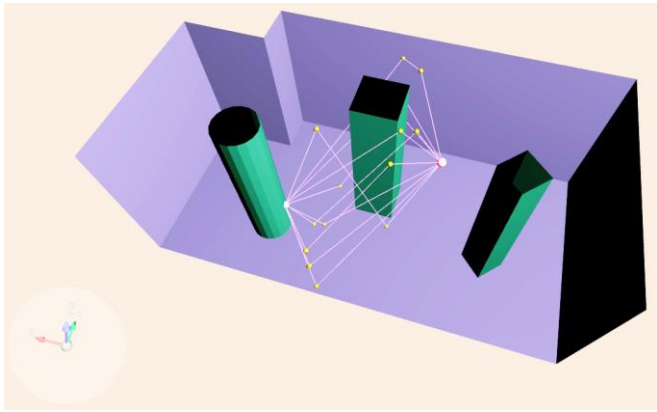


Figure: Sample results of the proposed automation tool compared to industry-standard simulator results.

A Ray Tracing Simulator for Radio Wave Propagation Based on Geometric Algebra

Port-Said University

Researchers from Port-Said University has developed a working a ray tracing algorithm based on formulating the geometry of environment, rays, and geometric operations using Geometric Algebra (GA). Accurate channel characterization is important in the design and deployment of wireless networks. Electromagnetic Ray Tracing is an effective computational electromagnetic method that is used for studying electromagnetic wave propagation in complex scenarios. Dr. Sherif Abuelenin, associate professor at Port-Said University stated, “Geometric Algebra is a comprehensive mathematical framework that unifies different mathematical systems such as complex numbers, vectors, and linear algebra. GA-based formulation is more compact and uniform, and geometrically significant compared to formulations based on linear algebra.” Generative programming is used for optimizing the code generation. Results indicate that combining the powerful mathematical modeling capabilities of geometric algebra with automatic code generation resulted in improved performance of the ray-tracing implementation.

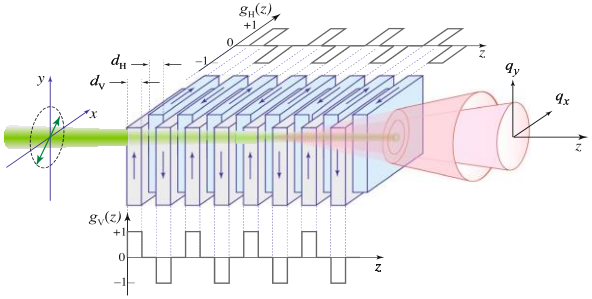


Visualization of Simple 3D indoor ray tracing scenario with maximum of two reflections per ray path.

Production of highly pure hyperentangled photon pairs: A key for various quantum information applications

Zewail City of Science and Technology

Researchers from Cairo University, Zewail City of Science and Technology, and University of Central Florida have introduced a novel high-purity source producing photon pairs simultaneously entangled in momentum, frequency, and polarization. “High purity hyper entangled photons, interpreted as high-dimensional quantum systems, enable faster and more-robust quantum operations in future.” says Dr. Salem Hegazy, Assistant Professor at Cairo University and the principal investigator of the project. The source consists of a photonic superlattice; a periodic thin-layered structure with alternating orthogonal optic axes, combined with periodic poling along orthogonal directions. The superlattice employ the highest nonlinear coefficient to enable efficient splitting of each laser photon (input) into photon pairs of high correlation in every degree of freedom. By combining periodic down conversion of orthogonally polarized photons along with periodic poling that corrects the phase mismatch, the structure self corrects for longitudinal walk off as it happens and before it accumulates. Each of the two orthogonal sets of nonlinear layers acts like spacers that engineer the group-delay of the emission of the other set. “Each emitted pair consists of two photons highly correlated in all properties, or so called: hyperentangled, which is a cornerstone in realizing all the fascinating features of quantum information and quantum computation.” says Prof. Salah Obayya, Director of Center for Photonics and Smart Materials, Zewail City of Science and Technology.



High-dimensional quantum systems

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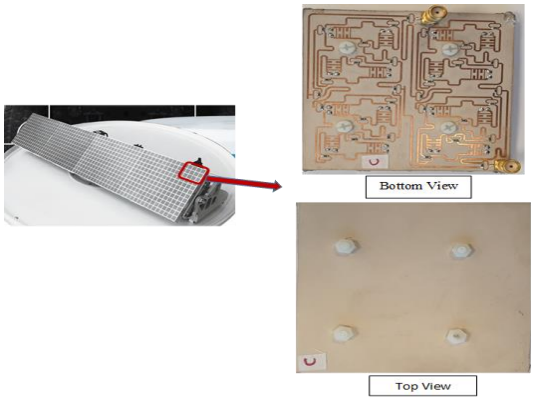
Circularly Polarized Ku Band Sub-Array Antenna for On-Move Earth Segment Satellite System

Electronics Research Institute

A group of Professors at the Electronics Research Institute is developing an antenna array for on-move earth segment for Ku band satellite communication systems. “Movable earth segments have quite importance in developing satellite communication where it may not be possible to use wired or other wireless links. This situation is popular for home-security applications in deserts or ships at far distances from shores.” Says Prof. Ahmed Attiya, Professor of Antennas and Microwave Engineering, Electronics Research Institute. The proposed movable earth segment can be adjusted on a car, a ship or other similar vehicles. The printed antenna could be adjusted and controlled by a mechanical system, which can be used to adjust both its elevation and azimuth directions. The designed antenna array is included inside a fixed cylindrical radom. This property makes the proposed antenna has a better advantage compared to other systems based on movable reflector antenna. In addition, the aerodynamics of the cylindrical radom is more stable than the corresponding one of reflector antenna.



Ku band satellite communication systems

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