Department of Radio electronics and telecommunications

Development of communication systems based on chaotic radio-physical oscillators
Duration: 3 months

Supervisor: As.Professor Nataliya Stankevich (language of training English)

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Audience: graduate students, undergraduates and young scientists with a PhD degree.

One of the promising areas of the practical application of radiophysical generators of chaotic signal is their use for data transmission systems. For two coupled generators in the mode of chaotic oscillations, phase synchronization is possible: the oscillations of the generators remain chaotic, while being absolutely equivalent each generator. The discovery of chaotic synchronization led to the development of a secure information transmission system: when a signal is generated on the transmitter side using a chaos generator, which is mixed with the information one, then it is transmitted through an open communication channel, and a chaotic signal is subtracted and the information signal is detected on the receiver side.

Today, this direction is promising, because unlike the ubiquitous digital encryption, this is a fundamentally different method of encoding information for which well-known decoding methods based on the theory of cryptographic information protection will not work.

The recent discovery of a matched filter for chaos finally enabled the much anticipated realization of both high-bandwidth data communications and ultra wideband radar exploiting broadband chaotic waveforms. Technology demonstration systems incorporating this discovery are currently being developed to target advanced radar applications, wireless communications, and random number generation. These systems exploit a new class of chaotic dynamics, for which an analytic solution can be written as a linear convolution of a fixed basis function and a symbolic dynamics.

In the frame of the training main principles of constructing radio-physical generators of chaotic signals and development of the data transmission system based on the chaotic generators will be studied. Students will get experience as in numerical and circuit simulations such kind systems, as development of the device in experiment will be implemented.

Research methods: physics, theory of oscillations and waves, numerical simulations
Software systems: C++, Phyton, MultiSim, LabView

Topics of the internship:
1) mathematical models of radio-physical generators of chaotic oscillations;
2) circuit models of radio-physical generators of chaotic oscillations;
3) experimental implementation of radio-physical generators of chaotic oscillations;
4) data transmission system based on synchronization of chaotic generators.

Goals of the internship:

1) mathematical modeling of radio-physical generators. Construction and investigation of phase portraits, Poincarè sections, Lyapunov exponents, Fourier spectrums;
2) development of circuit scheme of radio-physical generators with analog simulation with the software package MutiSim;
3) development of chaotic generators with programmable microcontrollers;
4) development of chaotic generators with analog microcircuit;
5) development of data transmission system based on synchronization of chaotic generators with programmable microcontrollers and analog microcircuit.

Modeling and computer-aided design of passive microwave devices
Duration: 1 month

Supervisor: Professor Vyacheslav V. Komarov (language of training English)

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Audience: graduate students, undergraduates and young scientists with a PhD degree.

Methods of mathematical modeling and optimization of various passive microwave devices widely used in practice of computer-aided design of radio electronic systems will be studied.

Research methods: finite element method, method of moments, finite-difference time domain method, least square method and some analytical approaches to simulation of electromagnetic fields in microwave passive devices.

Objects of study:
1) 1D periodic structures: metal gratings with circular and rectangular lamels;
2) 2D periodic structures: frequency selective surfaces for filtration and absorption of electromagnetic waves;
3) 3D waveguide and coaxial functional microwave devices: matched loads, filters, transitions.

Audience: graduate students, undergraduates and young scientists with a PhD degree.

Research topics:
1) Finite element modeling of arbitrary shaped homogeneous transmission lines by using PDE Toolbox of MATLAB software.
2) Simulation of planar microwave filters with the help of Sonnet Lite software and method of moments.
3) Optimization of waveguide T-junctions by means of μWave Wisard software.
3) Calculation of transmission characteristics of metal mesh gratings of mm-wave range.
4) Application of statistical package TableCurve-3D for 3D approximation of numerical data.

5) Numerical-analytical approach to simulation of dispersion characteristics of transmission lines with inhomogeneous dielectric filling.