The goal of the project is investigation of dynamical properties of mechanical systems exhibiting complex self-excited oscillations, that is supplied by a constant in time energy source or parametric oscillations, where an important role is played by certain system parameters variable in time. The dynamic properties of energy sources, such as various types of drives, including electric motors, e.g. DC, will also be taken into account in these tests.. The research concerns mechanical systems with a finite number of degrees of freedom and mechatronic systems, i.e. mechanical systems with advanced control, using elements of electronics and computer science. These types of systems may exhibit previously unknown bifurcation scenarios, i.e. changes in dynamics for slowly changing parameters, or these scenarios may be relevant from the point of view of applications in mechanical engineering or mechatronics. The project's objectives also relate to the detection, analysis and control of complex and potentially unknown physical processes and bifurcation dynamics of such systems, including complex resonances, parametric resonances, synchronization, regular and chaotic vibrations.

In frame of the project there are realized the following mutually connected tasks: 1) friction models and numerical solutions of parametric self-excited systems; 2) parametrically excited systems with ideal/nonideal sources of energy; 3) nonideal source and self-excited parametric oscillators with friction; 4) multi-degree-of-freedom self-excited parametric oscillators with friction; 5) parametric resonances; 6) friction induced self-excited oscillations of a double spatial pendulum; 7) bifurcations and synchronization of chains of translational-rotational stick-slip oscillators; 8) dry-friction-induced vibrations in single and in coupled mechanical oscillators; 9) mathematical modeling and numerical investigations of bifurcation dynamics in mechanical systems with belt drives and transporters; 10) physical pendulum forced by periodic torque-angle excitation. Investigations concern dynamical systems occurring or modelling phenomena occurring in mechanical engineering and mechatronics. They involve the creation of a mathematical description of physical phenomena and special procedures allowing to obtain their numerical solution.. In many cases, these models are then experimentally verified by estimating model parameters and matching the solution of model equations to experimental data, followed by model validation for other experimental data. The appropriate mathematical model then allows for better understanding and explanation of the observed phenomena or detection of previously unknown phenomena and then their experimental verification. During the project it is widely used the previous experience of the investigators, including studies and special mathematical models of systems with dry friction and impacts, real resistance to motion in bearings and magnetic interactions.

The topic of the project has been taken up due to its potential cognitive and purely scientific values. In such systems, dynamic phenomena previously unknown or poorly known may occur. Mathematical modeling and the methods of numerical solving the corresponding equations in many cases require special approaches. This applies especially to systems with dry friction and impacts. In addition, tested systems and dynamic phenomena can find potential equivalents and applications in industry. Knowledge of the bifurcation dynamics of a mechanical structure or mechatronic system allows them to be designed to avoid adverse effects. Knowledge of the mathematical model allows predicting the behavior of real systems in a much faster and cheaper way than using experimental research. The mathematical model enables fast and correct design of mechanical and mechatronic systems.

The most important expected outcomes of the project include fuller knowledge of dynamical phenomena occurring in parametric and self-excited mechanical and mechatronic systems, z with account of the energy source properties. The project will also result in original mathematical descriptions of this type of systems and corresponding numerical simulation methods.