MOTIVATION and AIM

The research project concerns the electromechanical coupling problem in the system consists of the set of magnets and coils applied to the energy harvesters. The literature study show that the electromechanical coupling (called transduction factor) is modelled as a fixed value for given parameters. The simplification causes reduction of one degree of freedom. Then the electromechanical coupling is treated as the electrical damping. Moreover, this approach does not included the coil's inductance. This approach can lead to the wrong results, especially for the high oscillations.

The main goal and the novelty of the research project will be the possibility of shaping of the electromechanical coupling functions by the proper designed levitated magnet, consists of set of smaller magnets and the neutral magnetic elements (called separators) and special designed modular coil with the variable inductance. The symmetric and non-symmetric construction of the levitation magnet will be analysed. It is expected that the proper design of a main oscillating magnet can significantly modify the coupling function and increase the efficiency of energy recovery.

The second goal of this project is to develop of non-linear models of the electromechanical coupling, which will include both electrical parameters and the magnet-coil configuration. The preliminary study, show the magnet vibration centre position has a significant influence on the energy recovery level. The developed electromechanical models will be applied in the vibration and energy harvesting analysis of the levitating magnet.

The proposed models of electromechanical couplings include the mechanical and electrical interaction. Additionally, a new element in the research project will be including the coil's induction controlled by the movable ferromagnetic core and the shape of the magnet (different distribution of the magnetic field). Finally, the developed maglev systems with the proposed electromechanical coupling models will be applied in the vibration mitigation systems to effective energy recovery. This is important especially in the vibration mitigation conditions.

METHODOLOGY

The project knowledge occurring in electromechanical systems requires a combination of methods from various scientific disciplines, such as mechanics, electronics or mechatronics. In order to achieve the assumed scientific goals, new non-linear models of electromechanical couplings in various variants of the magnet coil system will be developed. The special stacks of magnets will be designed (symmetrical and asymmetrical), which can levitate in a special unique modular coil's system (coil consist of the module set of coil segments). The coil segments can be modified and connect in various combinations (in series and in parallel).

Developed electromechanically coupling models will be used in systems for energy harvesting with one/two/three degrees of freedom, which use the magnetic levitation effect (maglev harvester).

The project will carry out experimental research, numerical research (classical integration method, finite element method, continuation method) and analytical method (e.g. harmonic balance method). The experimental tests will be carried out with the help of the shaker, static machine and own systems for energy recovery.

An innovative concept for measuring the magnet's speed/acceleration in the coil based on photodiode systems will be developed. The standard measurement using a sensor or cameras is difficult, because the magnet "hides" in the coil and the effect of magnetic fields on the sensors interaction can observe. In addition, a friction model of the levitating magnet which is result of Earnshaw's theory will be developed and applied. This friction is variable and strongly influence on the dynamics.

The obtained results will provide additional knowledge about the interaction between the mechanical and electrical systems. In addition, they will estimate the possibility of increasing the level of recovered energy for similar dynamics of vibrations under similar conditions.