DESCRIPTION FOR THE GENERAL PUBLIC

OBJECTIVE and MOTIVATION

Worldwide there is an estimated 500 million people who suffer from hearing loss. Up to now, there is still lack of effective treatment both to sensorineural and conductive hearing loss. An active middle ear implant is one of the most innovative method of hearing loss treatment. Therefore, an explanation of the active implant role in the middle ear structure and its influence on the human ear dynamics **is the main objective of the project.** Since, the proposed in the project, the biomechanical model of the human middle ear with an active implant is nonlinear, the system response can be regular, e.g. periodic, quasi-periodic, sub or super harmonic or even chaotic.

RESEARCH METHODOLOGY

The thoroughgoing knowledge about phenomena occurring in the human middle ear with an active implant needs to use various research methods applying in biomechanics, mechatronics as well as in otolaryngology. To obtain the scientific aims, a new physical and mathematical nonlinear model of the intact human middle ear is developed. Next, the model of intact ear is used to describe the human ear with an implantable middle ear hearing device which is used in the treatment of sensorineural and conductive hearing loss.

Testing programme provides for analyses of the human middle ear with an active implant in case of two types of implant actuators: electromagnetic and piezoelectric that are coupled to the biomechanical model of the human ear. To describe the coupled biomechanical and electrical model, the nonlinear differential equations of motion are defined. Next, to solve the equations, analytical and numerical methods will be engaged. The results will be verified by experimental tests on the human temporal bones. In theoretical considerations, the multiple time scales method (MTSM) will be used to find periodic solutions of the multi degrees of freedom nonlinear model. Next, bifurcation analyses will be performed numerically to find quasiperiodic, sub- and super-harmonic solutions and chaotic motion as well. Finally, to complete and verify the method mentioned above, experimental research will be performed on the specially prepared set-up equipped with Laser Doppler Vibrometer.

The results of the research project will widen knowledge about an influence of the implantable middle ear hearing devices on sound transmission through the human middle ear. Moreover, the outcomes should explain influence of the ligaments and tendons relaxation on hearing process in case of the intact ossicular chain and the ear with the active implant device.