Machinery systems (mechatronic, robotic) are an integral part of our lives. A coffee grinder, an autonomous vacuum cleaner, food processor are nowadays an indispensable element of every household. It is similar in large enterprises that perform various tasks for society, like production and supply of heat, water, electricity, the production of cars or airplanes. They all require advanced technologies. The increasing complexity of machinery systems, rising precision of their assembly (and smaller tolerance ranges) make it practically impossible to supervise their work by a human. Unfortunately, like any physical system, machine systems are subject to degradation processes. Damage to a coffee machine component can in most cases cause the owner's frustration due to the lack of coffee. Unfortunately, unexpected damage to the planetary gear in the helicopter rotor drive system during the flight can lead to a tragedy. Therefore, there is a **great need for research in the field of maintaining the technical condition of the infrastructure**, in particular machinery systems. This applies in particular to the commonly used elements of machine systems, such as gears or rolling elements bearings. Rolling elements bearings are ubiquitous elements of gears in drive systems, the role of which is to change rotational speeds and moments of forces. Both gearboxes and rolling elements bearings, are standard and universal elements of rotor systems.

In practice, this means the need to develop systems of machinery supervision that not only will have the ability to measure certain physical parameter and process these data properly to obtain information about the current technical condition but also build knowledge regarding degradation processes (how the machine breaks down when it happens and for what reason). Research of this type has been conducted for many years by hundreds of research centers around the world.

The aim of the project is to develop methods of obtaining diagnostic information. A novelty in the project is the use of advanced, original **computer modeling and simulation** techniques in the analysis of physical phenomena in the planetary gear and to create a support for diagnostic data analysis methods with theoretical knowledge of **mathematics** (theory of random processes, advanced statistical methods) and **electronics** (digital signal processing).

In the research plan proposed in the project, a team of scientists from China and Poland will focus on the most difficult cases, so far overlooked or considered with many simplifying assumptions ("otherwise it was impossible..."), namely on the **variable operating parameters** of the machines (variable external loads on the machine, variable rotational speeds) and the elimination of **impulsive disturbances** in diagnostic signals.

The purpose of processing the recorded signals is to "extract" information that a degradation process has started in the machinery element. In most cases, as in medicine, the detection of a "disease" at its early stage is very difficult, especially when the **non-informational component** of the diagnostic signal is **dominant** (in the energetic sense), **variable over time**, and when it has a complicated form **of random impulse** disorders.

The result of the project will be a set of **diagnostic procedures** for the elimination of impulse disturbances, description of variable operating conditions of the machine, identification of the signal structure using new time-frequency or frequency-frequency representation algorithms. The developed procedures and algorithms will allow for the detection of an informative signal, and its description using innovative modeling methods for cyclostationary processes, separation of the informative signal from a mixture of vibrations of different origins and properties with the use of advanced algebra methods (matrix factorization, sparse matrices).