Machines are omnipresent in our lives. We encounter them not only at home or in public space, where they make our daily lives easier, but also in factories, where they support the production of all those things we use today. Unfortunately, just like humans, machines also have their "health problems". Increased temperature, abnormal "blood" pressure (i.e., oil), aging and component degradation are just a few examples of such human-machine similarity. Based on senses of hearing, smell, sight or touch, a doctor can assess the health of a patient; by analogy, a machine health specialist - a diagnostician - can assess the technical condition of a machine using vibration, acoustic, temperature and other measurements. The goal of the project is to replace the doctor and his skills and knowledge with a mobile robot with specialized sensors and algorithms that process the collected data. The project focuses on so-called predictive maintenance of machines operating in difficult, inaccessible conditions, such such as underground mines, chemical plants, nuclear power plants, oil rigs or generators in wind turbines. Machines should be monitored, but often installing sensors on a large scale is economically unviable, and human presence in such areas - very risky. This is an ideal place to use mobile robotics. The goal is to ensure reliable machine operation, reduce unexpected failures, and optimize repair work schedules to minimize costs and resources. The project is limited to assessing the condition of rolling bearings because, depending on the sources, they are the cause of about 20 – 30 % of machine failures. The research focuses on three key areas:

- *Development of a measurement methodology for remote condition monitoring of rolling bearings in industrial machinery.* The first step of any diagnosis is to collect information from the patient. Since machines do not directly provide all relevant data, it is necessary to prepare a set of specialized tools - this includes both the selection of appropriate sensors and the development of procedures for their use.
- *Development of advanced methods for processing acoustic and video data.* Raw measurements typically contain information that needs to be prepared in a way that facilitates its interpretation by decision-making algorithms).
- *Development of a methodology for fusion and analysis of multichannel and multidimensional data.* Although using a variety of data broadens the range of analytical approaches available and improves the quality of the final results, it is necessary to determine when and how different types of data can work together. Once these issues are resolved (preferably in the form of an algorithm), previously unseen information can become an important part of the decision on the state of the machine.

Unexpected machine failures can lead to costly downtime, safety hazards and destruction of assets. Traditional maintenance methods cannot be used here due to the unfriendly human environment (temperature, risk of poisoning gas, etc.) and the high cost of monitoring systems (large number of objects requiring attention). The purpose of the proposed research is:

- Replacing classic monitoring or inspection methods based on human labor with robot-feasible inspections,
- Replacing classic temperature or vibration monitoring with sound-based diagnostics,
- Development of methodology for fusion of audio data with RGB and IR (infrared) camera data
- Extension of machine life; saving resources and reducing waste,
- Improving safety through early detection of damage and minimizing presence of potential failures.

Anticipated outcomes of the project include the following:

- Development of a sensory system for a mobile robot designed to collect diagnostic data for large-scale infrastructure: a device integrating a microphone, microphone array, RGB camera, and IR camera, with the ability to aim the microphone directly at the object under investigation based on the initial localization of the source by the IR camera and microphone array,
- A novel methodology for processing sound signals for damage detection: tools for predicting changes in machine condition and planning repairs,
- Data fusion methodology (audio, video, thermal imaging) to improve inspection quality,

By providing the right tools for mobile robot-based inspection, the project will contribute to improving human safety, extending machine life, and reducing maintenance costs. It will contribute to more sustainable operations in various manufacturing sectors.