The project concerns the use of the space-time finite element method in solutions of problems described by hyperbolic differential equations, in our case in the vibration of structures or wave problems. This method is characterized by special properties that enable continuous or discontinuous in time adaptation of the spatial mesh, but first of all, separation of the resulting equations in the system of algebraic equations already in the process of formulation of characteristic matrices. Natural separation of unknowns allows implementing algorithms on parallel processors. As the main aim, software for massively parallel computing carried on GPU graphics processors will be created. It will then be used to identify selected parameters of structures under dynamic load.

Graphics processors GPU are specialized for performing repetitive operations when rendering (imaging) three-dimensional graphics. Behind such a visualization complicated geometrical calculations are placed. So a concept was created to transfer some of the duties of the central processor to the graphics card. The existence of much faster tools for computer simulations also enables efficient multi-criterial optimization in structural dynamics. As a consequence, dynamic inverse problems are within the scope of computational possibilities. The use of GPU in scientific and engineering calculations is not a new idea. Currently, many commercial computing packages use this technology: *Ansys, LS-DYNA, MSC Nastran, Matlab* and many more. Unfortunately, classic algorithms do not bring expected results.

The following hypotheses will be elaborated and respective problems solved.

- Space-time finite element method with a particular scheme of time-space partition gives an enormous increase of computational efficiency in mass parallel computing on GPUs. Computer algorithm and programs will be elaborated for 2 and 3-D structures.
- The space-time discretization, which is a generalization of the finite element method, enables a non-stationary division of the structure with node relocation and the introduction of new ones, i.e. the adaptation of type r and continuous h. Particular mesh adaptation will allow solutions of problems with unbounded media subjected to moving load systems. Multi-scale methods nowadays applied with success to static or quasi-static problems, now will able to be solved with required accuracy in the case of waves passing through different media described in different scales.
- Identification of selected parameters of the structure under dynamical load. Obtained computer codes for the rapid solution of dynamical problems will enable the elaboration of algorithms for identification of selected parameters based on registered time responses of the real objects. The magnitude of the moving load, its velocity, a variation of an overall stiffness will be identified. These quantities are essential for structural health monitoring and for an indication of damaged elements.

Software using graphics cards to simulate the dynamics of elastic media and in the future of liquids and gases will create a new group of applications. It will be possible to use these algorithms for dynamic multi-scale calculations, which until now have not been implemented in the dynamics at all or implemented piecemeal and incorrectly. This group includes medical issues that need to be processed in real time, including soft tissue mechanics, fluid flows in blood vessels, surgical planning on the brain, and prediction of tissue deformation during surgical intervention, including those performed by work. This, in turn, radically accelerates solutions and allows the inclusion of time-consuming dynamic simulations to processes of parameter identification, in general, inverse problems. This, in turn, opens the way to an effective assessment of the quality of structure - Structure Health Monitoring. A future important area of potential applications of computational algorithms is ultrasound or X-ray imaging of tissues as a group of identification and inverse problems.