In the immediate future, mobile robots along with robotized service vehicles will play an increasingly important role in various sectors of intelligent transportation and service industry. Their effective utilization will necessitate automated execution of complex motion tasks requiring agile maneuvers in a cluttered environment. We know from everyday experience that realization of such tasks is very difficult. Why do we slow down when driving in a cluttered environment? Why bicycles and cars cannot be turned around on a narrow road without reversing? Why is it so hard to park in a busy parking space? Why maneuvering with an articulated vehicle equipped with trailers is so non-intuitive and absorbing? The answer lies in kinematic constraints and additional limitations imposed on feasible motion of wheeled vehicles with restricted mobility. Kinematic constraints result from the assumption, that in nominal conditions the vehicle must move along wheel rolling direction, i.e., no lateral slip can occur. As a consequence of this assumption only motion in certain *natural* directions depending on a vehicle configuration can be executed. Additional constraints concern vehicle configuration variables, that is, its admissible position and orientation resulting from the presence of various obstacles in a workspace, bounded angles of steering wheels determining limitations on maximal motion curvature, and bounded articulation angles guaranteeing avoidance of collisions between particular segments of an articulated vehicle. On top of that, if one considers bounded amplitudes of control signals, the issue of driving mentioned vehicles under all the imposed constraints becomes a very complex and non-intuitive task even for experienced drivers.

The goal of this project is mathematical algorithmization of complex motion tasks in the presence of constrained configuration variables and control inputs for a subclass of vehicle kinematics with restricted mobility, with particular emphasis put to bicycle/car-like kinematics and articulated vehicles with an arbitrary number of single-axle trailers. Motion geometry of such vehicles can be described by a kinematic model in the form of a strongly nonlinear driftless multidimensional first-order differential equation. While the general structure of those equations is the same for all the considered kinematics, their particular forms are characterized by a significant increase in complexity with respect to the number of variables describing vehicle configuration. Because of that, to simplify the task of algorithmization, we propose to apply a cascaded approach, according to which complex kinematic structures will be decomposed to simpler generic components coupled with each other. Hereby, the complex multidimensional problem will be solved in a modular manner. Algorithmization will be conducted under currently developed *algorithmic control theory* as a result of tight coupling between specialized motion planning stage (i.e. controller-driven planning) and motion execution stage in the form of an appropriately selected feedback control strategy. Thanks to application of the aforementioned methodology, it is expected that solution of the stated research problem will provides new insight into the geometric structure of complex motion tasks defined for wheeled vehicles and yields algorithmic tools facilitating automated planning of execution strategies for these tasks along with guaranteed satisfaction of imposed constraints in practical (non-nominal) conditions of vehicle motion.

In the course of this project, development, formal analysis, and simulation-based verification of possible motion strategies for different scenarios and different variations of imposed constraints will be performed. Experimental validation of developed algorithms will be conducted on a laboratory setup endowed with a robotized articulated three-trailer vehicle (with configurable number and hitching type of trailers) along with external image processing system utilized for localization of the vehicle in a workspace. Analysis of experimental results is directed at efficiency verification of the developed methods under (nearly) practical motion conditions, in which the issues like modeling uncertainty, the presence of noisy measurements and possible potential violations of several assumptions made during formal analysis, must be considered.

Developed algorithms can be utilized in the future as an element of a decisive-and-control system for mobile robots or as an ingredient of expert system of robotized commercial vehicles. It is anticipated that obtained results will be a starting point for possible future applications of the proposed approach also to other dynamical systems possessing similar properties of their kinematic models.