APPLICATIONS OF PHYSICS IN MECHANICAL AND MATERIAL ENGINEERING
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Experimental studies of the influence of wheel slip on the motion of a four-wheeled mobile platform

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ABSTRACT

The main goal of the research was to investigate the impact of a slip in the wheels of a mobile robot on its motion parameters. Experimental tests were carried out with use of Leo Rover during the realization of the adopted robot test runs. Both the parameters describing the motion of individual wheels and the parameters of the observed platform motion have been recorded, in relation to the selected point of the object. The basis of the analysis was the comparison of the track mapped from the recorded values of the rotation angles of the wheels with the parameters read from the record of the actual path of the platform motion. As a result, the occurrence of wheel slip during platform movement has been found, especially in the stages of starting and braking. Based on the recorded values of the trajectory and velocity, the differences in the course of the position and the velocity obtained during the same test runs have been indicated.

SCOPE OF RESEARCH

The aim of the research was to experimentally verify the theoretical models of the dynamics of the mobile platform motion. The test consisted in recording the values of the forcings applied during subsequent drives, at each time the maximum speed values, and then comparing them with the values read from Record of the actual motion.

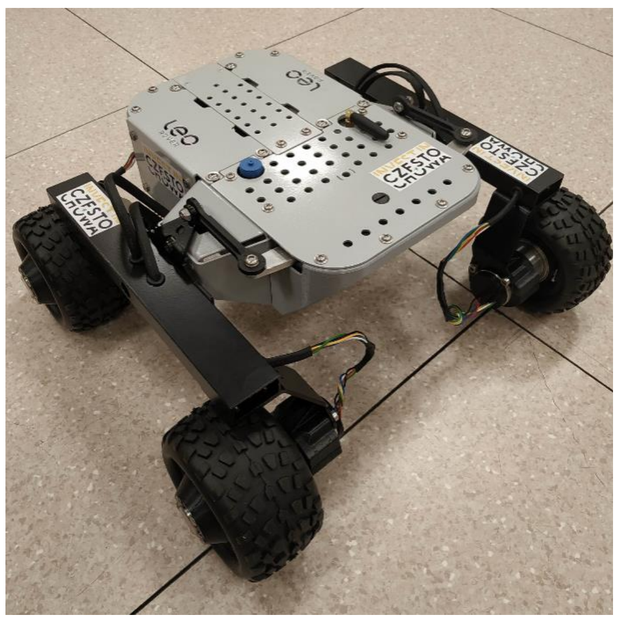

Fig. 1. LEO Rover – research object

INITIAL CONDITIONS

In the analysis were assumed that the origin of the coordinate system, with respect to which the motion parameters were described, is at the assumed tracking point, i.e. at the point marked in blue.

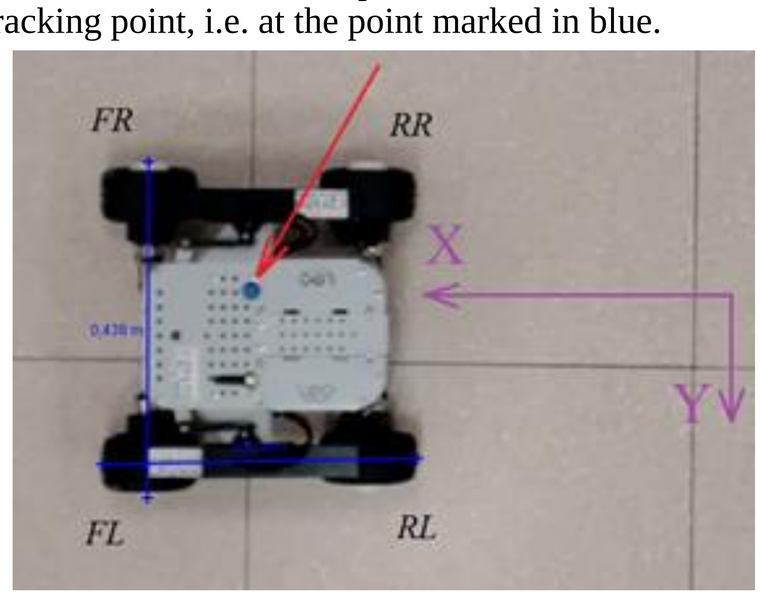

Fig. 2. The origin of the coordinate system

Tab.1. Initial parameters

Parameter	Value
Radius of wheel [m]	0,064
Weight of the platform [N]	61
Coordinates of initial position wheel FL [m]	[0,140 ; 0,233]
Coordinates of initial position wheel FR [m]	[0,140 ; -0,124]
Coordinates of initial position wheel RL [m]	[-0,150 ; 0,233]
Coordinates of initial position wheel RR [m]	[-0,150 ; -0,124]
Total worktime [s]	9,141

RESULTS OF EXPERIMENTAL STUDIES

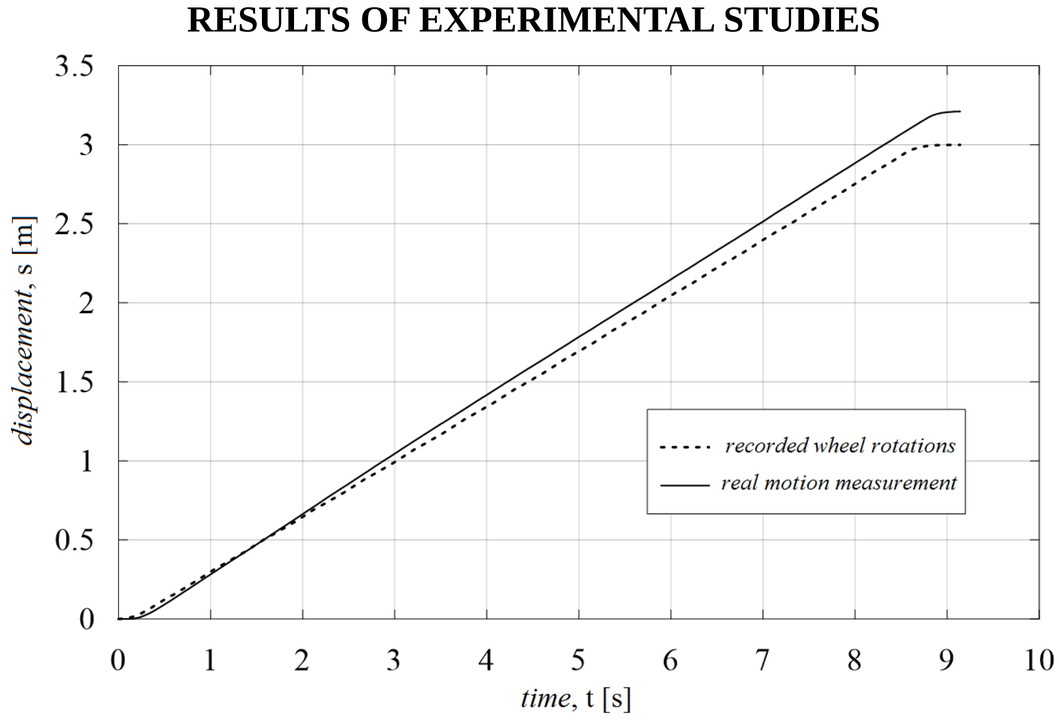

Fig. 3. Differences in displacements between recorded parameters

In the first second the recorded values of the real motion of the robot are lower than those determined on the basis of the record of the robot's wheels rotations, which means that there is a slip between the wheel and the ground, because the wheels rotate faster than the distance of the real robot motion measurement.

In the last part of the motion, i.e. in the period when the robot begins to brake, the behavior changes, and the value of the distance, recorded as the real motion of the selected robot point, is higher than that determined on the basis of the record of the robot's wheels rotations. This, in turn, reflects the slip which is also characteristic of vehicles in the braking phase, since the wheels are no longer driven as a result of the stopping of the wheels and the displacement increases.

The possibility of the wheel slip phenomenon occurring during the robot's motion has been shown, which is the basis for the development of models, identification of their parameters and simulation tests in a wider range of possible motion configurations, with considering possibility of wheel slip.

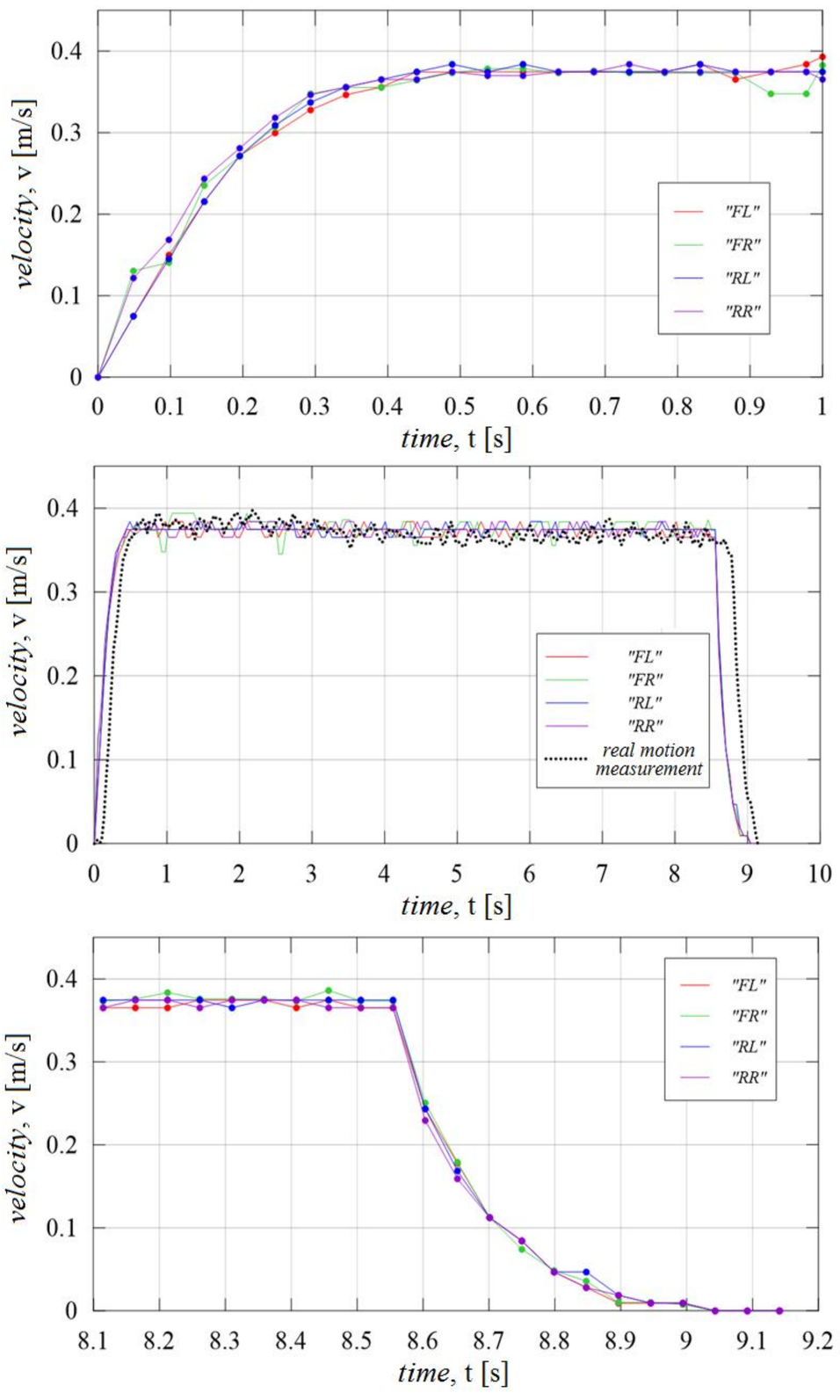

Fig. 4. Velocity a) in the first second, b) during the entire motion with reference to the course of the actual observation point, c) in the last second

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2. Jaskot A., Posiadała B., Śpiewak S.: "Dynamics Modelling of the Four-Wheeled Mobile Platform", Mechanics Research Communications, Vol. 83, Elsevier, 2017, s. 58-64, DOI: 10.1016/j.mechrescom.2017.05.007
3. Jaskot A., Posiadała B.: "Dynamics of the mobile platform with four wheel drive", MATEC Web of Conferences 254, Machine Modelling and Simulations 2018 (MMS 2018), 2019, 8s., DOI: 10.1051/matecconf/201925403006