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Dynamics model of the mobile platform for its various configurations

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Abstract

Description of the dynamics of the four-wheeled mobile platform has been proposed in the paper. Proposition of different configurations of load with consideration of distribution of load to each wheel of the mobile platform is presented. The prototype model is useful to examine different configurations of the drive wheels and to analyse the relations between causes and effects of the motion parameters. The problem of the forced motion of the platform, with the possibility to modify the drive modulus positions, has been considered. The various configurations of the driven wheels, which has significant influence for both the position of the center of mass and the distribution of load acting on the wheels, is presented in the work. The formulated initial problem has been solved numerically with use of the Runge-Kutta method of the fourth order. The analysis of several sample results for the different positions of center of mass has been conducted and the conclusions are also included.

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Keywords: dynamics; mobile platform; load distribution; forces in wheels;

1. Introduction

The objectives in realizing construction of the four wheeled mobile platform cover comprehensive studies of dynamic phenomena that can occur during the mobile platform motion. The research includes in particular the subjects of unsteady motion of the platform under the straight and curvilinear trajectories. The presented project of the wheeled mobile platform will be accomplished in such a way that it will allow the realization of the motion for many possible configurations of positions of wheels relative to the whole vehicle.

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The realization of proposed research is essential to know the platforms work that has significant meaning for both the optimization of the construction solutions and the selection of the operating conditions for the considered group of machines. Mobile robotics is a field of science, which still grows, hence there are many works in literature, covering the research issues at this point. One of the most often asked questions, considering the mobile platforms, is a description of motion, including the movement parameters, i.e.: coordinates of trajectory, velocity and acceleration of mobile platform and its elements. The works [6] and [2, 3, 10, 12] refer to description of motion of two, three or more than three wheeled mobile robots. The kinematic and the dynamic analysis including the trajectory tracking and path generation for nonholonomic systems are a continually common matter. In previous studies the kinematics of wheeled mobile robots has been the main subject in planning the control of nonholonomic systems. The analysis of motion planning with consideration of the dynamics equations is proposed among others in [11, 13]. Proposition of the trajectory planning problem for multi-objective is widely described in [9]. The formulation of tracking control of a group of mobile robots with guarantee of no collisions between robots is proposed and described in [5]. Approach to the kinematic and dynamic solutions for the possible positions of the wheeled platforms are proposed in [2].

Knowing the differential equations of motion the simple or inverse task of the dynamics can be solved. Due to the complex form of the equations describing the motion of the system in the inverse task of the dynamics, the solution of it can make a problem. This paper presents a solution to the inverse problem of dynamics. The motion parameters can be determined by using the Euler's parameters and Kane's method as described in [1], Maggie equations in [4], Langrange method in [2]. The effect of this is generating and implementing the trajectory of the platforms motion. In this paper the solution with use of the Runge-Kutta method of the fourth order is included.

The design of the mobile platform prototype, with description of the constructional elements is contained in [7].

2. Model of dynamics of the mobile platform

In this section the theoretical and computational models of dynamics of the four-wheeled mobile platform are presented. The previous studies on the kinematics confirmed the correctness of the analysis for proposed solution of the mobile platform.

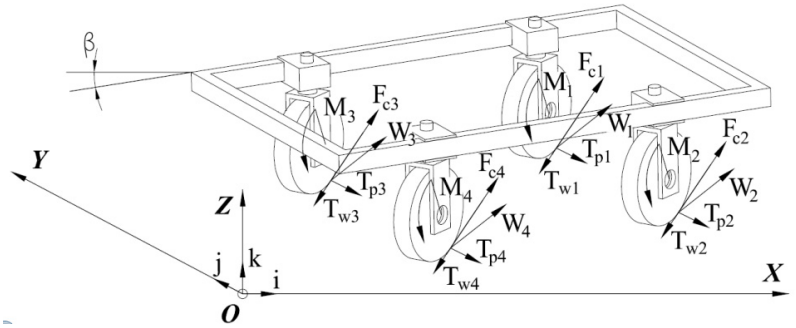

Fig. 1. Force distribution in the mobile platform model.

The model shown schematically in Figure 1 is adopted in order to describe the dynamics of the mobile platform prototype in the configuration coordinate space. The model is built to conduct the analysis of the behavior of the platform when it is subjected to various configuration of load. In Figure 1 the forces occurring during the

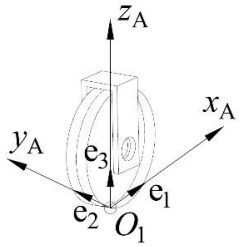

Fig. 2. Representation of local coordinate system for *A* wheel, analogous to each one of the remaining wheels.