Modelling and simulation of movement of dispersed group of mobile robots using Simscape Multibody Software

Michał Siwek, MSc[1, a)] and Leszek Baranowski, DSc, PhD[1, b)]

[1]Millitary University of Technology, Faculty of Mechatronics and Aviation,
Witolda Urbanowicza 2, 00-908 Warsaw

[a)]Corresponding author: michal.siwek@wat.edu.pl
[b)]leszek.baranowski@wat.edu.pl

Abstract. The paper presents the process of modelling the movement of dispersed group of mobile robots using the MATLAB Simulink and Simscape Multibody software. As a modelled object, a group of laboratory robots, TurtleBot, was adopted. First, the construction of a robot CAD model is described. Next, the control system developed in Simulink is described. At the end, the robot components were defined in Simscape Multibody and a group movements analysis was carried out.

INTRODUCTION

Simulating the work of designed machines has become an everyday element of the work of engineers and constructors. Verification of the device based on computer simulation allows to eliminate defects or optimize the design at the design stage. Complex constructions or processes require special attention and analysis of the constructor. A good example of a complicated mechatronic device is a mobile robot. In the literature there are many descriptions of different environments to simulate the work of robots. The trajectory of robot movements can be simulated and visualized, e.g. in MATLAB Simulink. An example of the simulation of movements of a group of robots with a dispersed structure using MATLAB / Simulink is presented in the paper [1], where the effect of disturbances of external control signals on group movements was considered. The paper [2] presents the use of calculation functions available in MATLAB / Simulink to analyse the movement of a load being lifted by a crane. An interesting example of simulation is the paper [3] where simulation of cooperation between an industrial robot and a mobile robot is presented.

Considering the simulation environments due to the operating system of robots, we can distinguish environments dedicated to the Robot Operating System (ROSROS is a programming library for Linux that allows you to quickly create software for mobile robots. The application of the Rviz environment dedicated to ROS is presented in the paper [4]. It describes the integration of a robotic arm with a vision system. The application of the Gazebo environment dedicated to ROS is presented in the paper [5] where the cooperation of wheeled mobile robots is described

This paper presents the use of Simscape Multibody software to simulate the movement of a group of robots with a dispersed structure. Simscape Multibody enables modelling of multi-object systems using blocks describing system components, forces and defined external constraints. Simscape Multibody formulates and solves the equations of motion for the entire mechanical system. It allows you to import the CAD model of the object with all physical parameters and visualize the dynamics of the system.

DEVELOPMENT OF THE ROBOT SIMULATION MODEL

The CAD model of the laboratory robot TurtleBot2 (Fig. 1) was developed in the SolidWorks environment on the basis of a real robot available in the Robotics Laboratory of the Faculty of Mechatronics and Aviation MUT.

During the modelling process, the robot components were assigned mass and material, which allowed to determine the moments of inertia of the robot in relation to the selected axes. Next, the coordinate system was defined as in Fig. (1). The center of the coordinate system is the center of the robot's movement in the subsequent simulation.
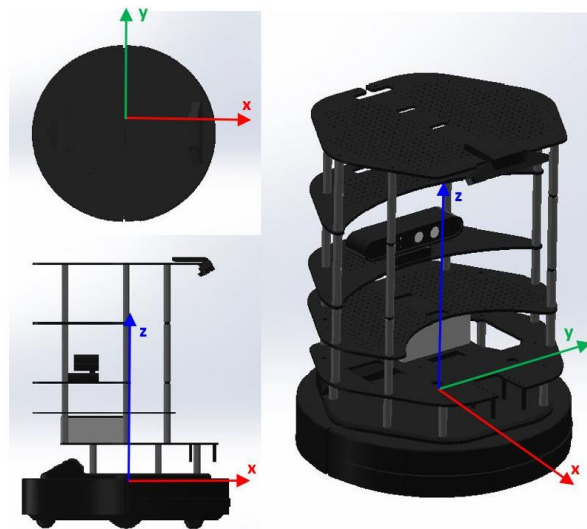

FIGURE 1. The CAD model of the laboratory robot TurtleBot.

The group of robots under consideration was formulated from four TurtleBot robots. Next, geometric constraints on the position of each robot were defined. Constraints imposed correspond assumption of a group of dispersed structure, where there is no direct relationship between the coordinates of the positions of the individual robots. The coordinates of each robot are calculated relative to the common, mobile global reference system. The control system for the implementation of the group's motion along a set trajectory was built on the basis of the paper [1]. Next, a simulation model of the TurtleBot robot was developed in the Simscape Multibody software, which, when combined with the control system, enabled 3D visualization of the trajectory.

Summary

The paper presents the use of Simscape Multibody software to simulate the movement of a group of robots with a dispersed structure. The necessary step is to develop a CAD model that accurately maps the simulated object. Analysing the obtained simulation results and visualization, it was found that the Simscape Multibody software is suitable for simulating the movement of mobile robots.

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