

SUMMARY

Digital manufacturing is the rapidly developing approach to manufacturing process, which provides tools for visualization and analysis of industrial processes, production layout configurations, and assembly solutions, simulation of industrial robotic systems, fast and secure problem handling, and many more. Digitalization helps to improve efficiency of the production, optimize performance of the system, and solve possible problems of the production process even before implementing it on the real site.

One of the possible solutions to the digital manufacturing is the digital twin concept. Digital twin is a digital copy of existing manufacturing system, which enables monitoring and control of the real system from a specifically designed computer programme in a timely manner. Integration of such system with virtual reality provides a human presence simulation and a multiplayer functionality, which makes it a powerful tool for training and studying purposes.

The goal of the thesis was to implement the digital twin solution of the ABB IRB1600-10/1.2 industrial robot located at the Flexible Manufacturing Systems and Robotics Demo Center in Department of Mechanical and Industrial Engineering at TalTech. This work was a part of a bigger project started by the Industrial Virtual and Augmented Reality (IVAR) laboratory — a full-scale copy of the Robotics Demo Center in Virtual Reality environment.

By the means of the thesis project, a full-scale digital models of the ABB robot mounted on the mobile platform and an IRC5 controller were imported in the IVAR laboratory virtual environment. Special interface to control the virtual model simulation and connection to the real robot was designed and implemented. For the robot programming simulation in virtual environment, inverse kinematics (IK) solution was found. Inverse kinematics is the relation between the coordinates of the end-effector and the joints rotational angles. It is an important aspect of programming robot motion. IK solution is used in the RAPID code (a proprietary programming language for the ABB robots) simulation. There is an opportunity to write a simple RAPID programme using movement instructions.

The connection between the real and virtual systems necessary for the proper setup of the digital twin concept was built using a personal computer software development kit (PC SDK) from ABB. PC

SDK provides a set of libraries necessary to establish a remote control of the ABB robot from the laboratory computer.

The implemented solution has proved to be working, even though there is a synchronization problem with the control of the real robot through the virtual model, based on the fact that with the current ABB libraries there is no possible way to control the joints movement directly, only through the RAPID command, which sets the speed of the TCP and not the speed of the joints. The solution to this problem is to be investigated in the future.