Industrial robot trajectories, speed and accuracy

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***Abstract*—This contribution is review article about research process on a dissertation exam with title Modeling and optimization of robotic and technological production lines. Dissertation deals with optimizing effector speed of an industrial robot to a required accuracy. The resulting system input will by parametric equation of trajectory, required speed or accuracy and output will be movement of robot's effector according to specified requirements.**

***Keywords*—industrial robots, optimization, speed, accuracy.**

I. Introduction

Nowadays is increasing computing power of processors and calculation is distributing between several processors, this is reason for expand the capabilities of many way of programming of many technologies. Industrial robots are one of mentioned technologies.

Controllers of modern industrial robots contain two types of computing unit. The first types are units for calculating of robot kinematics and dynamics. The second types are units for processing of program written by programmer of industrial robots. The first type of units also comprise movement model on basic trajectory (ellipse, straight line, point-to-point).

Article is dedicated for dissertation. This dissertation is about accuracy and speed of industrial robot's effector on specified trajectories. These trajectories will be able to be specified to robot by parametric equation. After specifying trajectory, industrial robot will move on that trajectory with required speed and accuracy. During movement on specified trajectory, robot will not use own program for movement (mentioned movement model), but program developed by dissertation, which this article describes.

II. Initial state

During the diploma thesis [1] was processing, two problems found. Diploma thesis was not solves these problems.

The first problem was speed of industrial robot's effector. Despite the fact that the speed was set to a specific value, the robot was not move with this speed. This problem solved publication Optimizing industry robot for maximum speed with high accuracy [2].

The next problem was small option of movement trajectories. Programmer of industrial robots can mostly use only three types of trajectories and these trajectories are ellipse, straight line, point-to-point, specifically. When diploma thesis was solving, mentioned trajectories was not sufficient. That was reason for created functions for added movement described in publication Control of robot integrated in flexible production line [3].

A small selection of trajectories and necessary of functions for new trajectories leaded to next research. This research described contribution Industrial robot optimization for required accuracy and speed [4]. This contribution designed function where input is parametric equation of curve (trajectory) for industrial robot movement.

Robot's effector speed will be optimized through density of defined points on required trajectory. These points will calculate online in program loop. This loop will be programmed in robot controller. Trajectory will be defined by parametric equation in mentioned loop. New point of trajectory will calculate in each loop. Article [4] describes iteration step, this step will modify in such a way that robot will have required speed and accuracy. User will be able to define whatever parametric equation in function or text file. Industrial robot optimizes for required speed and accuracy will operate by three ways:

1. optimization for required speed,
2. maximum speed optimization for required accuracy,
3. speed optimization for required accuracy and speed.

A detailed description of these three types of optimization is in contribution [4].

Result of mentioned work was thorough analysis of effector movement of industrial robot MELFA RV-2DB [2], design of new movement options of robot by functions [3] and by universal function for any trajectory [4].

III. Description of the tasks solved in previous year

Next aim is associated mentioned results to complex system, which is described in thesis for dissertation exam [5]. This complex system will contain:

1. function for robot movement along a defined trajectory using the parametric equation of the curve (trajectory),
2. optimize the speed of the robot's effector by set the iteration step [4], [5],
3. diagnostic tool for diagnosis speed and accuracy.

This system will be tested on an industrial robot MELFA RV-2SDB and on an industrial robot model named Robko, which are DCAI (Dept. of Cybernetics and Artificial Intelligence) models. An important task was calculated the direct and inverse kinematics (mathematical model) to these industrial robots.

Direct and inverse kinematics was calculated in publication Mathematical model of robot Melfa RV-2SDB [6].

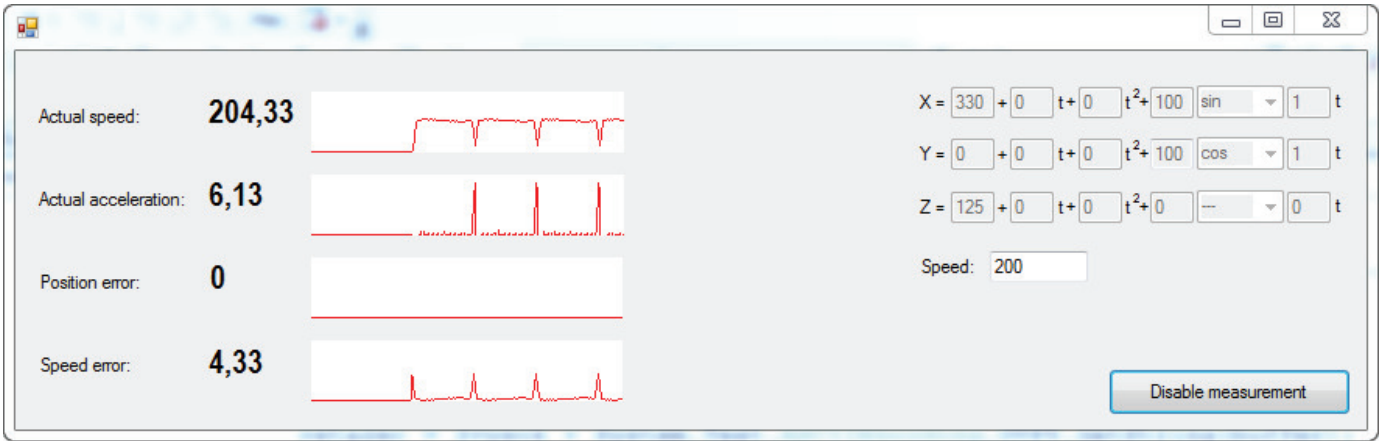

Fig. 1. Diagnostic tool for movement of industrial robot MELFA RV-2SDB

When mathematical model was creating, then university textbooks [7], [8] and [9] were helpful.

When the mathematical model of industrial robots was known, then it was necessary to create a mentioned diagnostic tool. The first and basic design of tool was discussed in [2] and [5]. Diagnostic tool will serve as a monitoring of optimization algorithms, which these algorithms are one of the objectives of dissertation. This mentioned tool is near at the end of realization and so far it has not been written for its any publication.

Application screen can be seen above this text on Fig. 1. This application is programmed in programming language C# in development environment Visual Studio. This application monitors the actual speed and acceleration of the robot, calculated from the current position of the robot's effector. Application receives information about the current position of robot's effector from robot controller through RS-232 interface. To application can specify parametric equation of curve. When parametric equation and current effector location are known, then it can be calculated position error. This error can be seen in application on graph and in real time as number. The application also monitors the speed error, because the desired speed is known. Free place in the middle of application is intended to render position of effector in space.

Control and diagnostic of industrial robot are distributed therefore was used methods described in [10].

IV. Conclusion

Continuation of research can be divided into three phases. The first phase will consist of the following tasks:

- complete rendering of effector position in space,
- program robot controller so as program input will be parametric equation of curve,
- program optimization resources mentioned in [5].

The second phase will consist of the following tasks:

- verify created functions on real model,
- create and description of methodology for optimizing robot speed in relation to accuracy,
- verification of methodology in terms of laboratory models of the department.

The third phase will process these results into a dissertation.

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