Trajectory Generator Design by using B-Spline Curves

Ching-Chang Wong, Chia-Jun Yu, and Szu-Hao Lien

Abstract— In this paper, a trajectory generator by using B-Spline curves is designed for robot manipulators. It can quickly generate smooth curves. Moreover, it needs less memory to store the generated trajectories.

Keywords—Robot Manipulator, Trajectory generator, B-Spline curves.

SYSTEM ARCHITECTURE

In this paper, a trajectory generator by using B-Spline curves is designed to slove the problem of the artificially generated trajectories based on AutoCAD for a robot manipulator moving. The trajectory of the end-effector of a robot manipulator can be generated by using B-Spline functions. The B-Spline curves just utilize a few control points to generate a smooth trajectory and it can arbitrarily change the local shape of the trajectory [1][2]. The function is represented by

$$C(t) = \sum_{i=0}^{n} N_{i,k}(t)P_i , \quad t_{\min} \le t < t_{\max} , \quad 2 \le k \le (n+1) \quad (1)$$

where $\{P_i\}$ is a set of control points forms a control polygon. $N_{i,k}(t)$ is the ith B-Spline basis function of order k (degree k-1) with the knot vector t=$\{t_0, t_1, t_2, \cdots, t_i\}$, They are defined recursively as follows:

$$N_{i,1}(t) = \begin{cases} 1 & if \ \ t_i \le t < t_{i+1} \\ 0 & otherwise \end{cases} \quad (2)$$

$$N_{i,k}(t) = \frac{(t-t_i)N_{i,k-1}(t)}{t_{i+k-1}-t_i} + \frac{(t_{i+k}-t)N_{i+1,k-1}(t)}{t_{i+k}-t_{i+1}} \quad (3)$$

The trajectory generator by using B-Spline curves is constructed for robot manipulators [3] [4]. First, a software platform used on PC is designed with MATLAB [5] so that the users can add or remove control points to let the curves meet the desired trajectory. One example is shown in Fig. 1.
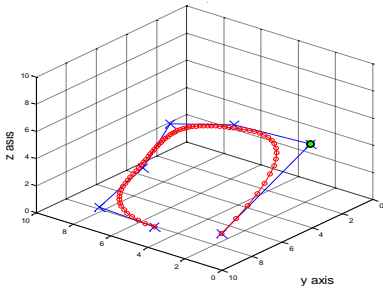

Fig. 1. Trajectory generated by using B-Spline curves.

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Then the position information of control points is obtained to be the input data of the trajectory generator of the robot manipulator. It can let the robot manipulator quickly generate a continuous and smooth trajectory. Moreover, it needs less memory to store the generated trajectories.

The trajectory generator by using B-Spline curves is designed. It will be implemented on a six-axis robot manipulator to illustrate that it can quickly generate a continuous and smooth trajectory. The block diagram of a control system structure for a six-axis robot manipulator is shown in Fig. 2. There are two main units: software strategy and hardware control. The control procedures can be described as follows:

1) Generate trajectories by using B-Spline functions.
2) A position command is sent to the Motion Control card by using PCI interface.
3) The control card transforms the command into control signal.
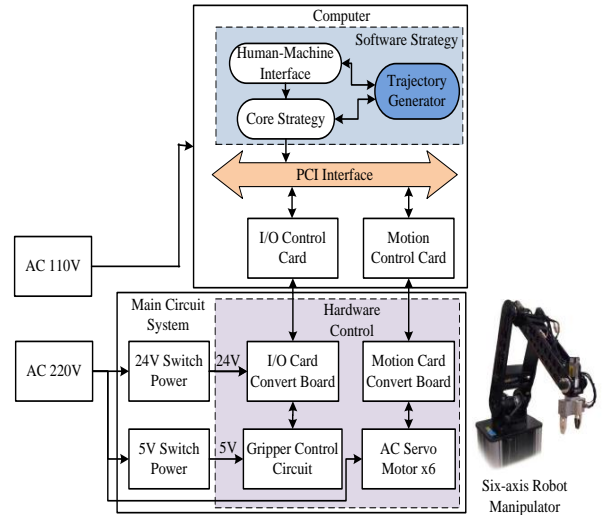4) The control signal is sent to the six-axis servo motor.

Fig. 2. Block diagram of a control system structure for a six-axis robot manipulator.

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