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Development of Trajectory Formation Tool for Optimizing Walk of Multi-joint Robot

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Abstract

Flexible movement is preferred for multi-joint robots. Rough, bumpy movement increases equipment abrasion and aggravates system load to cause motor breakdown. To guarantee flexible movement, temporal and spatial restrictions must be levied on routes between transfer points. Robot movement becomes dull when time is increased. On the other hand, movement becomes faster with shortened time but load is formed in system. Thus, a method for expressing and controlling method for specifying and planning route is required. This paper proposes a trajectory formation tool for solving this problem. This tool expresses trajectory movement of multi-joint robot and automatically creates angle value required for stable walk.

Keywords: Motion Creation, Multi-joint Robot, Optimizing Walk, Joint Angle

1. Introduction

Robot mobility and intelligence are general characteristics of multi-joint robots. Research on multi-joint robot has been mainly focused on finding the system dynamics and using this dynamics in control [1,2]. However, it is extremely difficult to find the dynamics of multi-joint robots as they possess large degree of freedom and instability of system can be generated by even the smallest of disturbances [3].

To achieve stable walk of multi-joint robot, ZMP(zero moment point) must exist within step board and gravity center of robot must be within the center line[4,5]. In order to satisfy such conditions, the robot must be equipped with intelligence to appropriately handle various situations like humans.

To display movements of multi-joint robot, trajectory within multidimensional space is used. Trajectory refers to the history of time in location, speed, and acceleration for each degree of freedom. Problems related to trajectory formation include the problem of interface with humans, which is related with the method of specifying and analyzing trajectory or route in space. To facilitate display of multi-joint robot movement by robot system users, users must be free from the obligation of writing complex functions of time and space. Rather, the user must be able to specify trajectory by simply describing the movement.

Flexible movement is always preferred for multi-joint robots. Rough, bumpy movement increases equipment abrasion and aggravates system load to cause motor breakdown. Thus, a method for expressing and modifying trajectory is required.

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This paper proposes a trajectory formation tool for multi-joint robots. The presented tool traces and expresses walk trajectory and finds the appropriate value to achieve natural joint movement. Correction value between angles is formed by time control method according to movement of multi-joint robot, thus producing more natural movements.

This paper is organized as follows. Chapter 2 explains about the method of controlling the robot by using trajectory trace method. Chapter 3 explains about the trajectory formation tool that realizes the trajectory trace method. Lastly, Chapter 4 mentions the conclusion and future research.

2. Robot Control Using Trajectory Trace Method

Flexible movement is preferred for multi-joint robots. Rough, bumpy movement increases equipment abrasion and arouses motor of multi-joint robot to cause vibration. Furthermore, system load can be aggravated to cause motor breakdown. Thus, flexible movements of robot must be achieved, and a function for creating such flexible movements is required. To guarantee flexible routes, temporal and spatial restrictions must be levied between transfer points. Many choices are required at this point, which in turn creates numerous methods for specifying and planning routes. Robot movement becomes dull when time is increased. On the other hand, movement becomes faster with shortened time but load is formed in system.

Thus, an environment for creating movements in motion creation tool and achieving direct execution in simulator is required. However, this paper explains about flexible motion creation by using trajectory in the existing robot motions. **Fig. 1** describes flexible motion creation between joints.

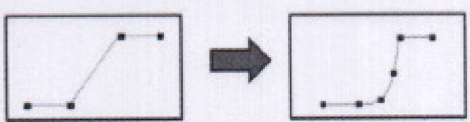

Fig. 1. Motion control of multi-joint robot through modification of trajectory value

The joint value of multi-joint robot can be presented in angle form in the process of moving the joint from initial starting position to target position. **Fig. 2** presents this relationship in graph form. θ regarding time t can possess various routes according to diverse coefficients.

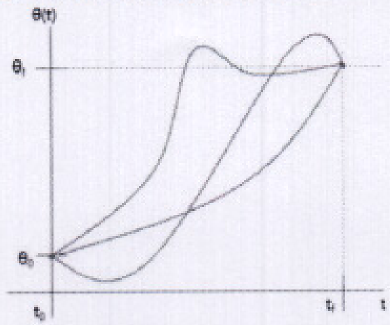

Fig. 2. Route shape of joint

The angle of joint formed by motion capture of multi-joint robot is as presented in **Fig. 3**. Large range of angles according to unit time, such as the values between sections 1-2, can damage motor and wear down components.

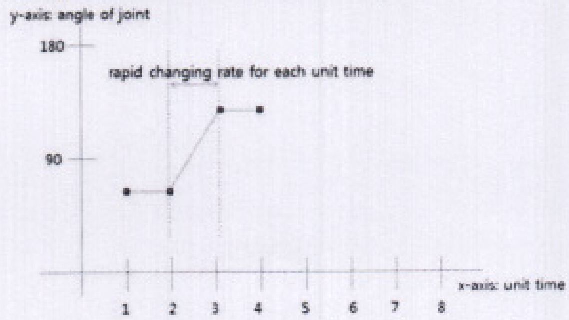

Fig. 3. Straight line-type joint trajectory

Due to such problems, the changing rate according to unit time must be decreased as presented in **Fig. 4**. Motion data can be inserted halfway to execute flexible motions. However, excessive data input may prevent the multi-joint robot from executing proper movements due to frequent movement control.

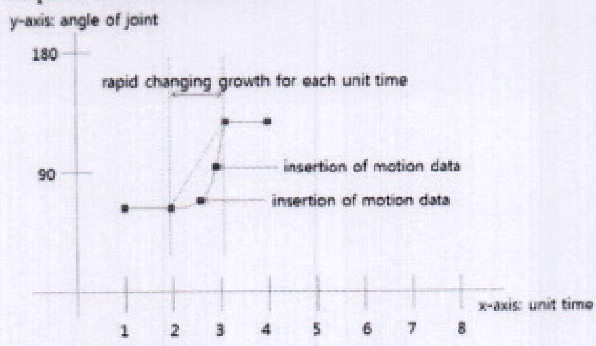

Fig. 4. Joint data input in unit time

For this reason, technology for segmentalizing points in curve is required (refer to **Fig. 5**). Otherwise, large amount of calculation in system is required due to frequent angle calculation of robot.

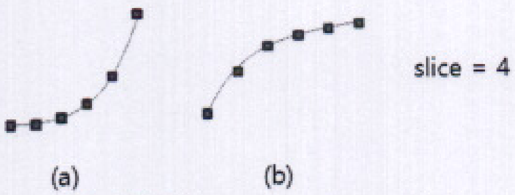

Fig. 5. Trajectory formation method

Basic applied graph types include straight line, downward curve, and upward curve. The user can also randomly define the graph. Bezier Curve[6] is used to draw curve.

3. Trajectory Formation Tool

Fig. 6 presents trajectory formation method in trajectory formation tool. Enter Slice value and press Create Point to form appropriate angle value in graph. ① in picture presents the location of coordinate values formed in the selected graph. ② expresses formed values in numerical values. Setup values in each section and execute Create File to extract trajectory-inserted motion data.

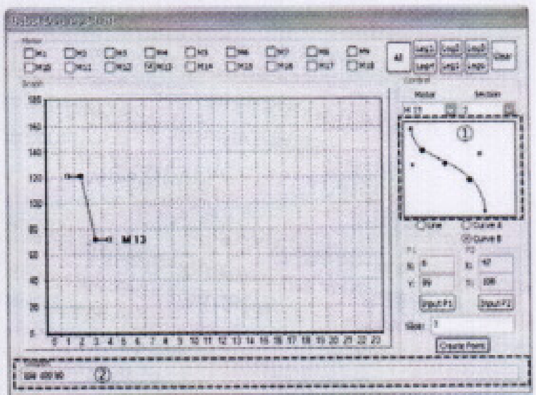

Fig. 6. Auto-formation of multi-joint robot trajectory

New data is inserted between sections 1-2 by re-importing extracted motion data (refer to **Fig. 7**).

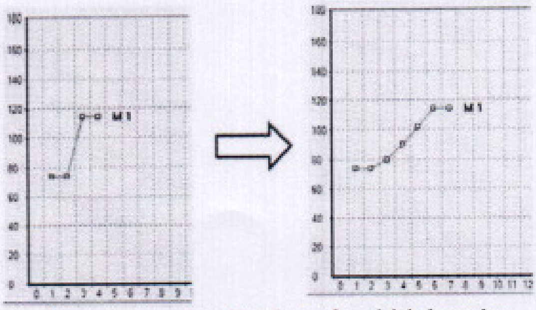

Fig. 7. Trajectory application of multi-joint robot

Fig. 8 presents the application of slice = 3 in 1-2 sections regarding forward movements.

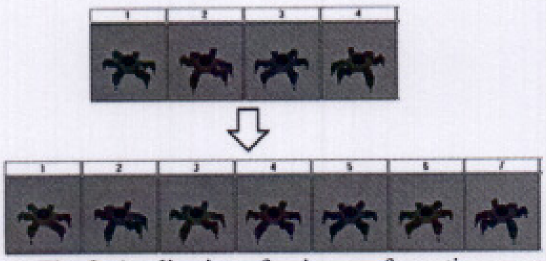

Fig. 8. Application of trajectory formation regarding forward movements

4. Conclusion

Rough, bumpy movement increases equipment abrasion and aggravates system load to cause motor breakdown. For this reason, flexible movements are required. To guarantee flexible routes, temporal and spatial restrictions must be levied on routes between transfer points. It is difficult to solve spatial and temporal restrictions by using general methods. Thus, a method for expressing trajectory as graph and modifying values is required. In this regard, this paper proposed the trajectory formation tool for multi-joint robots. The presented tool traces walking trajectory to express as graph and finds appropriate values to achieve natural joint movements. Through the use of multi-joint robot control, it was verified that more flexible movements were produced by using this tool when compared with the existing single motion formation.

Presently, this method is only applied in motion creation of multi-joint robots. However, an environment for progressing an experiment on the formation and execution of flexible trajectory is expected to be constructed through connection with simulator.

References

[1] Jae Soo Kim, Hyun Seung Son, Woo-Yeol Kim, R. Young Chul Kim,"A Study on M&S Environment for Designing The Autonomous Reconnaissance Ground Robot," *Journal of the Korea Institute of Military Science and Technology*, Vol. 11, No. 6, pp. 127-134, 2008.

[2] Hyun Seung Son, Woo Yeol Kim, R. Young Chul Kim, "Semi-Automatic Software Development based on MDD for Heterogeneous Multi-Joint Robots," *The International Symposium on Control and Automation (CA 2008)*, Hainan Island, China, pp. 93-98, 2008.

[3] Hyun Seung Son, Woo Yeol Kim, R. Young Chul Kim, "Implementation of Technique for Movement Control of Multi-Joint Robot," *The 30th KIPS Fall Conference 2008*, Vol. 15, No. 2, pp. 593-596, 2008.

[4] C. L. Shin et al., "Trajectory synthesis and physical admissibility for a biped robot," *Proc. IEEE International Conference on Robotics and Automation*, vol. 3, pp. 1646-1652, 1990.

[5] M. Yagi, "Synthesis of control strategies for planar biped robot locomotion in the presence of disturbances," Univ. of Wisconshin-Madison Robotics Lab. Tech. Report, no. RL-97002, 1997.

[6] Boehm, W., Farin, G. and Kahmann, J., "A Survey of Curve and Surface Methods in CAGD," *Computer Aided Geometric Design*, vol. 1, no. 1, pp. 1-60, July 1984.