Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 13 (21): 4714-4719, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.4714.4719

Virtual Prototype Technology Based on the ADAMS for Joint Type Robot

Jin-Ling Cao and Ying Luo
School of Energy Engineering, Yulin College, 719000 ,China

Abstract: Based on the robot joint Angle Parameterization and calculation of the movement end executor coordinates in the initial condition, by using the main control parameters for design variables, joint robot 3D parametric entity model was established based on ADAMS secondary development function, through developed joint type robot structure design module, by data processing and simulation analysis, determined the control parameters of the virtual prototype, improved model accuracy and obtained feasible joint type robot virtual prototype.

Key words: Joint robot, ADAMS, virtual prototype

INTRODUCTION

The ADAMS software is the most widely used virtual prototype analysis software; users can easily use the software on a virtual-machine system for statics, kinematics and dynamics analysis (Fang and Tsai, 2003).

Industrial robots generally refers to replacing people complete with a large-volume, high quality work required. Robotics is a multidisciplinary use. in many types of robots ,articulated industrial robot has a large flexible, very suitable for handling, welding and assembly (Boyaci *et al*., 2009) and other repetitive tasks. Robotics research and development is a national science and technology important indicator (Lee and Mavroidis, 2002). Therefore, based on virtual prototyping technology, articulated robot parametric design study will lay a solid foundation for theoretical study and application.

An overview based on ADAMS virtual prototyping technology: Virtual prototyping technology usually solve the traditional design and manufacturing process of the shortcomings from analyzing and solving issues related to the overall performance perspective. ADAMS occupies more than 50% of the market (Kim *et al*., 2000). It can be said ADAMS (Automatic Dynamic Analysis of Mechanical System) program is the world's most widely used and most authoritative mechanical system dynamics simulation software (Li, 2003).

The development of modern science and technology kept expanding scope in the field of robotics research, enrich the connotation and denotation of robots (Ceccarelli, 2002). According to the United Nations organization for standardization definition of robot (Xiang *et al*., 2003), the robot can be either a programmable and multi-function CaoZuoJi actual, can also refer to specialized system has to change and programmable action. The use of robots in the field of modern industrial life is more and more widely (Ast *et al*., 2009). So for type based on ADAMS joint industrial robot research has the vital significance both in theory and application.

By virtue of virtual prototyping technology, designers can directly provide parts and define the relationship between parts by physical information and geometric information on a computer, thereby obtain the mechanical system virtual prototype (Vaha and Skibniewski, 2001). Using system simulation software in a virtual environment, we can observe its movement in all circumstances and analyze the forces on each of the components. repeatedly modify the design defects by simulation of different designs, so the entire system constantly improve until the optimal design, then conduct a trial of physical prototype. The Virtual prototyping technology is the core of the mechanical system kinematics, dynamics and control theory (Lee and Chang, 2001).

Establishment of ADAMS model of the robot: ADAMS/view module steps to establish the imulation model:

Geometric modeling: Geometric modeling is the first step in ADAMS/view simulation analysis. To establish a good geometric model first and then through the constraint and load condition such as add a complete virtual prototype model, for the simulation analysis.

Corresponding Author: Jin-Ling Cao, School of Energy Engineering, Yulin College, 719000, China

There are three methods to obtain the entity model in ADAMS:

- Direct modeling with ADAMS, modeling tools
- Through the ADAMS/Exchange module from the external input model file
- Through professional graphics interface modules, such as Mechanical/Pro module

In this study, robot geometric model is established using method 1.

Impose constraints on the parts and movements: After created the geometric model, the next step is to define constraints. ADAMS/view constraints can be divided into four categories: Pair constraint (Joints), basic constraints (Joint Primitives), motion constraints (Motion Generators), high pair constraint (High Pair Constraints). According to the actual experiment robot, the model mostly use hinge t vice constraints and dotted lines.

The load in ADAMS: In ADAMS, the force can be divided into four categories: general force, flexible connectivity, special forces and contact forces. When define the force we need to set the size and direction of the force, it provides three ways to the setting: enter data directly, use the transfer function, input parameters of the subroutine . The direction of the force can be defined either by determining the connection between two points or along the axis.

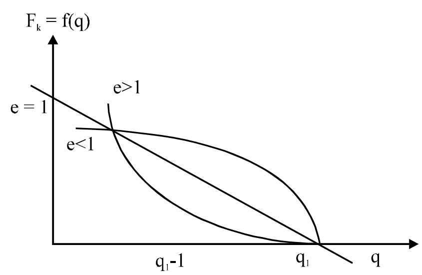

Fig. 1: Collision function spring force

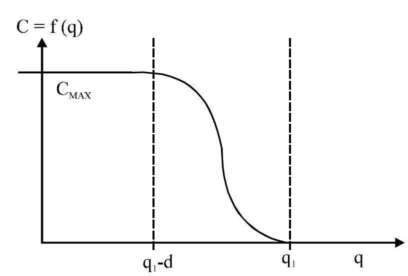

Fig. 2: Collision function damping force

The operation steps in ADAMS/view model simulation: ADAMS/Solver can execute own operation solution according to the setting, obtained displacement, velocity, acceleration, force and the reaction information and output the results according to needing.

The module parameter analysis in ADAMS/view: Parametric analysis is the study of design variables on the model performance. By changing the design value of the parameter, a series of simulation processes can be executed to obtain feedback on the target parameters. Such as collision function is a function to be activated depending on the independent variable "q" changes and if the displacement "q" is greater than "go", the impact force is zero, or the impact force is generated, the size of the impact force:

Impact force can be divided into two parts, one is the spring force and the other is the damping force.

ADAMS model of the robot: In the modeling interface, click on the menu Settings in the Working Gird which is Shown in Figure 3, Size is setting of 1000 × 1000 (mm), Spacing is setting of 50 × 50 (mm). Through the main Toolbox, the setting of background color is black. Set the background color, as shown in Fig. 3.

ADAMS calculate the mass and moment of inertia member according to the input density and geometry. In this study, use Geometry and Material Type, in the

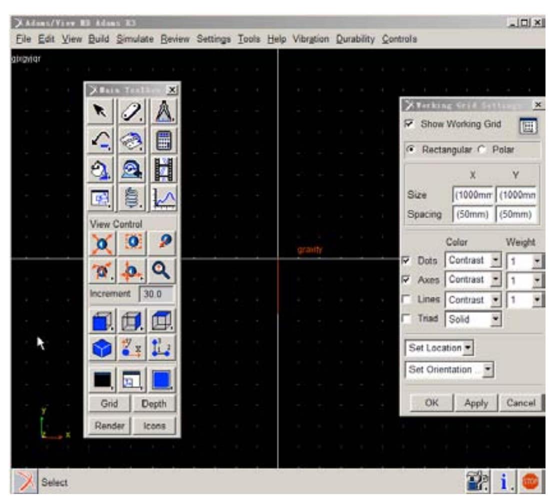

Fig. 3: The working grid and the

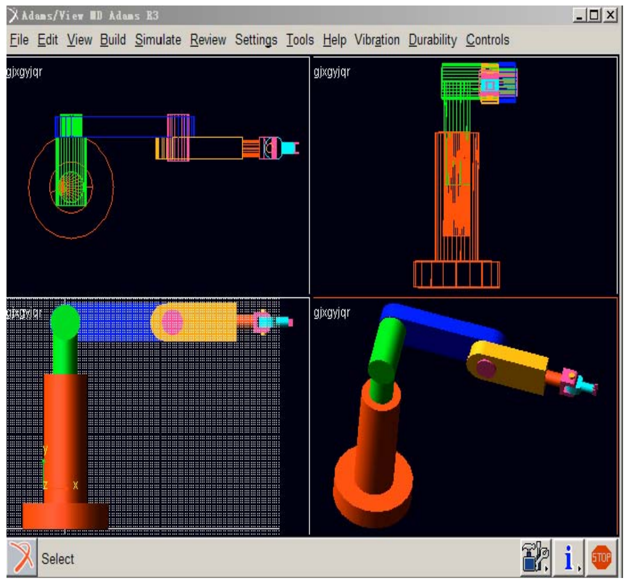

Fig. 4: Virtual prototype robot

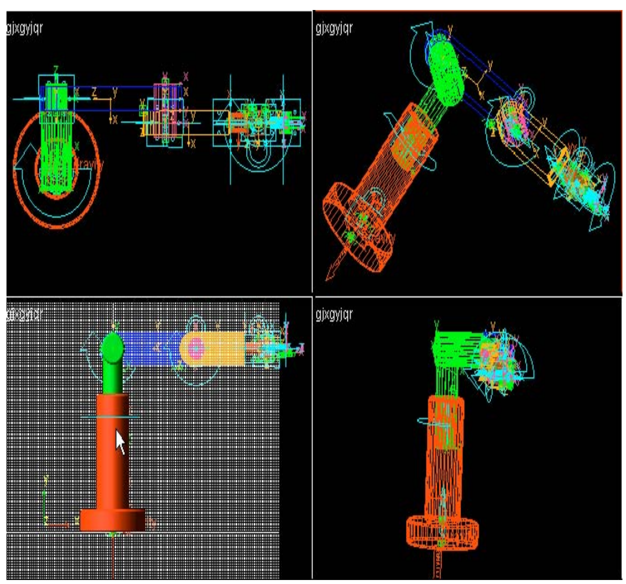

Fig. 5: Aadded constraints robot model

material library in ADAMS software, select a material. Entire virtual prototype can be divided into the chassis, base, arm, forearm, wrist, swingin and rotating parts shown in Fig. 4. Set the motion between each of the links, Chassis and earth which is fixedly connected, the base fixed to the chassis, the rest connect by rod hinged, after the treatment, the virtual prototype model shown in Fig. 5 shown.

By the upper steps, articulated industrial robot virtual physical model is set up. Through software self-test function, you can determine that the model is correct or not.

The Kinematics analysis of simulation results: Through the establishment of the robot kinematics equation, derive the position of the end of the robot and the robot tool and orientation parameters of joint variables, the relationship between the connecting rod is also obtained. By ADAMS/View measurement and simulation outputting function, t analysis the

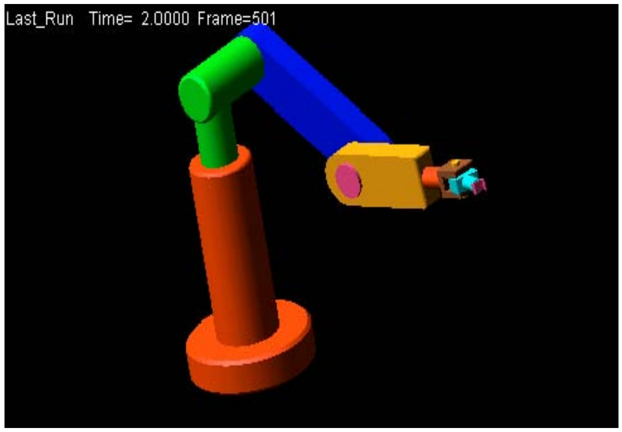

Fig. 6: The simulation process diagram

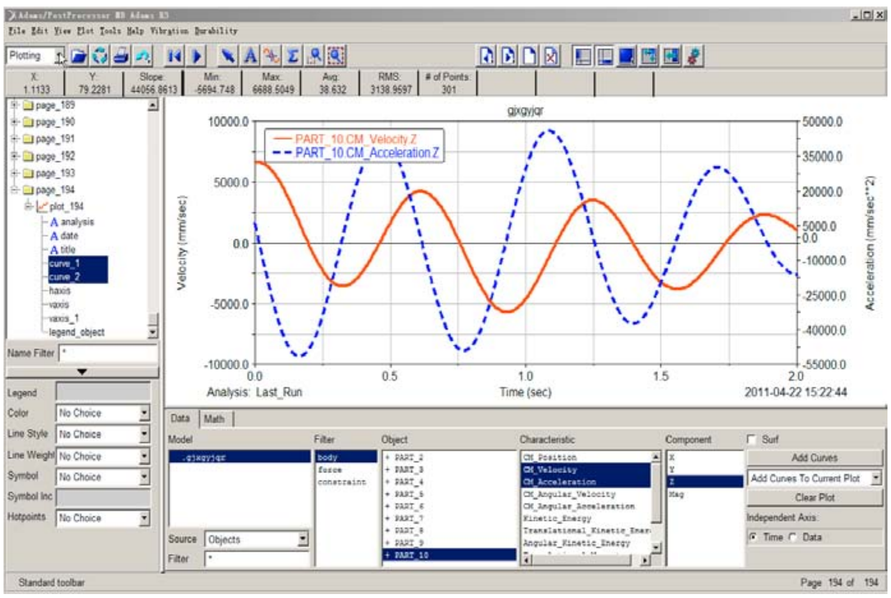

Fig. 7: The displacement of gripper in x y z

relationship between the parameters. The setting of End Times 2 seconds, the number steps is 500.

The kinetic analysis of joints and gripper: Figure 7 shows the displacement of the gripper is basically wavy line attenuation, displacement of the gripper subjected different constraints, make biased, so the starting point is not zero. Gripper velocity and acceleration profiles are shown in Fig. 8, the speed in the z-axis is the cosine curve, the amplitude decreases and when the acceleration reaches a maximum at 0.8 sec and periodically attenuation, the rate and acceleration of nodes is continuous, no significant acceleration of mutations. Angular velocity and acceleration curves of the gripper are shown in Fig. 9, the minimum angular velocity is 425.9539d sec^{-1} at 0.6867sec; acceleration curve gradually increases, reaches the maximum 1739.768d sec^{-2} at 0.78 sec and finally tends uniform wavy change. All those above meet the design requirements.

Shown in Fig. 10, the angular velocity and angular acceleration of the wrist showed regular changes, there is no mutation; from 0 to minimize the angular-249.7179 d sec^{-1} and then gradually increased to a maximum 262.1811 d sec^{-1}, approximately sinusoidal changed. angular movement begin to rise at -1382.1153 d/s2, cyclical changes for a continuous forward motion. Analysis of the results of Fig. 10 curves wrist, wrist

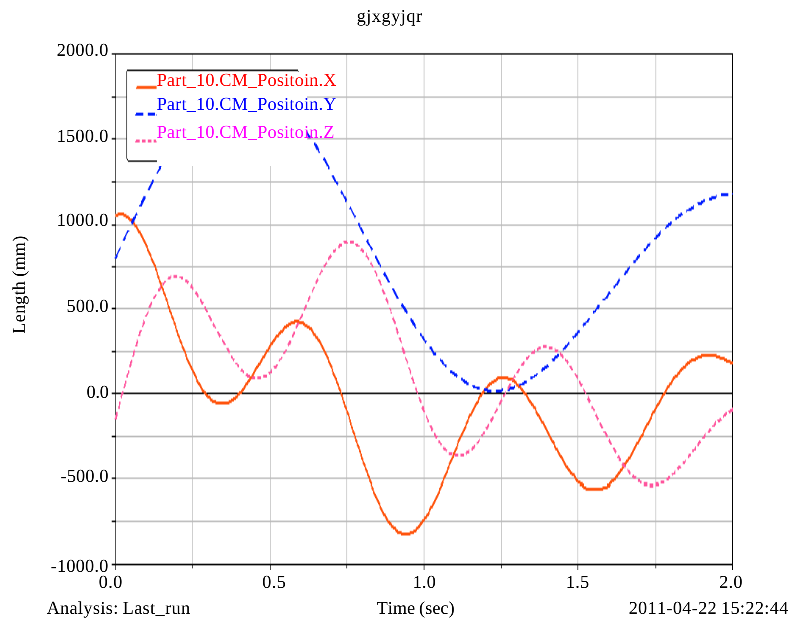

Fig. 8: Gripper speed and acceleration

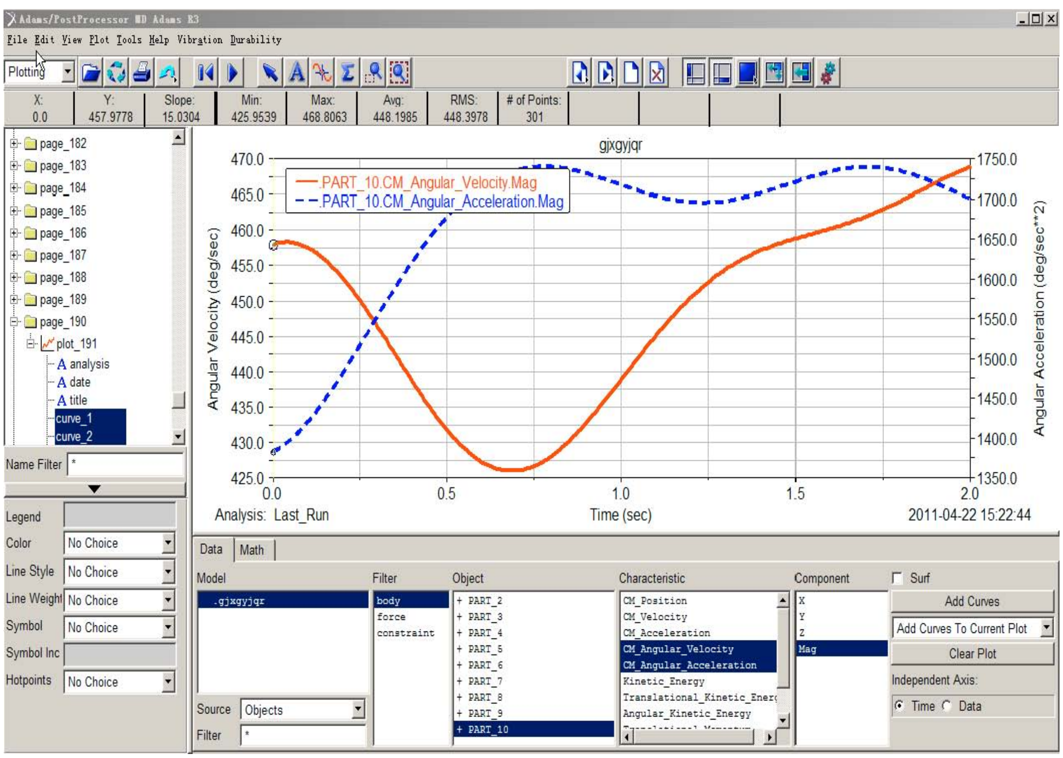

Fig. 9: Gripper angular velocity Figure10 wrist joint angular velocity

synthesis displacement decreased after increasing, at 1.2667 sec, it reaches the minimum 96.8368 mm, then increased gradually; velocity change is firstly decreased and then increased gradually, at last ,decreasing variation;

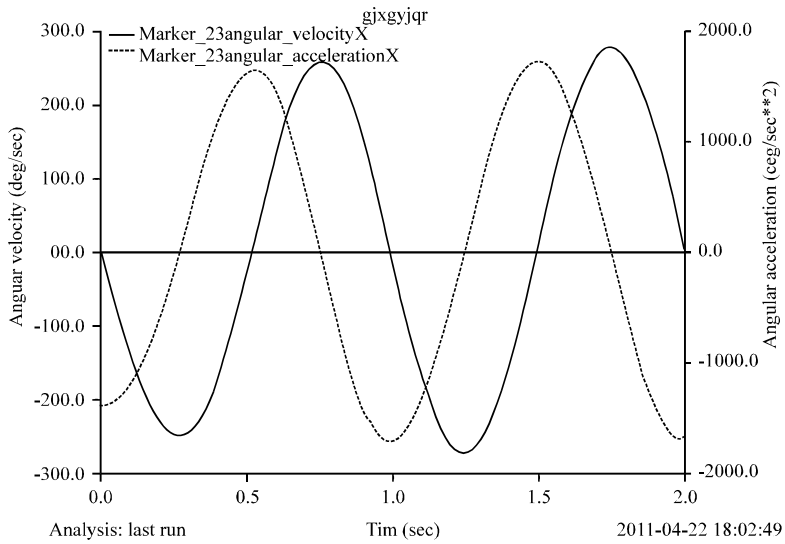

Fig. 10: Wrist joint angular velocity

acceleration change relatively flat, there is no point mutations ,gradually decreasing.

CONCLUSION

The simulation results is investigated the virtual prototyping technology on articulated robot in ADAMS environment, verify the correctness of the design of the machine model ,and do the appropriate analysis on typical structure, the results show that the articulated robot designed meet the design requirements. The work lay on a solid foundation on articulated robot parametric design on virtual prototyping.

ACKNOWLEDGMENTS

This stuidy is supported by Yu Lin College scientific research item imbursement (11GK53, 12YK24).

REFERENCES

Ast, A., S. Braun, P. Eberhard and U. Heisel, 2009. An adaptronic approach to active vibration control of machine tools with parallel kinematics. Prod. Eng., 3: 207-215.

Boyaci, A., H. Hetzler, W. Seemann, C. Proppe and J. Wauer, 2009. Analytical bifurcation analysis of a rotor supported by floating ring bearings. Nonlinear Dyn., 57: 497-507.

Ceccarelli, M., 2002. Designing two-revolute manipulators for prescribed feasible workspace regions. J. Mech. Des., 124: 427-434.

Fang, Y.T. and W.L. Tsai, 2003. Feasible motion solutions for serial manipulators at singular configurations. J. Mechanic. Design, 125: 61-69.

Kim, J., F.C. Park and M. Kim, 2000. Geometric design tools for stiffness and vibration analysis of robotic mechanisms. Proceedings of the IEEE International Conference on Robotics and Automation, April 24-28, 2000, San Francisco, California, pp: 1942-1947.

Lee, E. and C. Mavroidis, 2002. Solving the geometric design problem of spatial 3R robot manipulators using polynomial homotopy continuation. J. Mech. Design, 124: 652-661.

Lee, S.U. and P.H. Chang, 2001. Control of a heavy-duty robotic excavator using time delay control with switching action with integral sliding surface. Proceedings of the IEEE International Conference on Robotics and Automation, May 21-26, 2001, St. Paul, MA., USA., pp: 3955-3960.

Li, G., 2003. Different geometric configurations research of high speed hybrid bearings. J. Hunan Univ. Arts Sci., 3: 40-43.

Vaha, P.K. and M.J. Skibniewski, 2001. Dynamic model of excavator. J. Aerospace Eng., 6: 148-158.

Xiang, J., N. Gao and J.W. Jin, 2003. Application of clustering algorithm in network intrusion detection. Comput. E, 16: 48-49.