Design and mechanical analysis of mobile sliding platform based on creo and ansys

Design and mechanical analysis of mobile sliding platform based on creo and ansys

Yankai Hou*, Xiaodong Tan

Dalian Jiaotong University, School of Mechanical Engineering, Dalian, China

*Corresponding author e-mail: 842663937@qq.com

Abstract. Artifacts, based on large general indexes of spraying robot spraying space is difficult to meet the requirements, in this paper, the large surface, especially for complex shape, high quality demand of film product requirements, design a horizontal moving and lifting machinery, to meet the needs of spraying workpiece for the robot working space; Through Creo software, ANSYS software is analysed to ensure the stability and feasibility of the structure. Integrate the design process and analysis process and shorten the r & d and application cycle; It lays the foundation for the following trajectory planning module.

Keywords: Creo; ANSYS; finite element analysis; statics; dynamics; dynamic response.

1. Introduction

In the manufacturing process of railway passenger cars, the surface coating of the body is a heavy production link [1]. The defects of the flat car, such as the concave and welding joints, and so on, and then get smooth and smooth surface by grinding; this process has always been carried out by artificial scraping and grinding, and the operation environment of the artificial scraping coating is bad (the paint contains volatile toxic gases) and the quality uniformity of the scraping coating cannot be guaranteed [2]. And the quality of artificial scraping is also easily affected by the emotion; therefore, it is necessary to realize the automation of the car body spraying, and the manual needs to be liberated from the bad operating environment. In this paper, a set of horizontal direction and vertical direction is designed for the high 4m and long 25m car body, based on the angle of the mechanical device. The lifting mechanism can meet the space requirements of the large parts such as the car body and other large parts for the spraying robot, and solve the problem of the limitation of the working space of the general spraying robot.

The research and development process should undergo several design and analysis cycles and get the most suitable design scheme [3] after optimization. In order to improve the efficiency of design and analysis of circulation and shorten the [4] of R & D cycle, the traditional experience design process is integrated with the computer virtual reality design and analysis process. Some features such as the structure of the angle of the arc will be lost, such as the structure of the angle of the arcing zone, such as the [5]. In this paper, the seamless connection between the 3D design software CREO3.0 and the finite element analysis software ansys16.0 is made, and the special interface is used to direct the 3D model of the Creo into ANSYS directly, and the mechanical model features and elements will not be lost. The mechanical analysis of mechanical structure greatly saves time [6] for subsequent structural optimization design and analysis. Design flow diagram, as Figure 1:

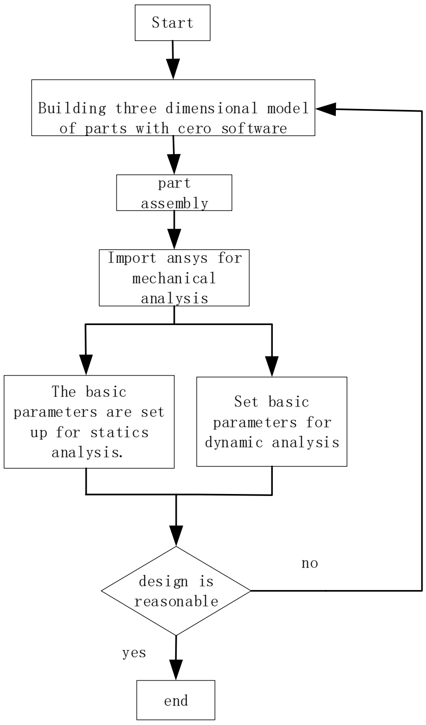


Figure 1. design flow chart

2. The establishment of 3D solid model

Creohas powerful 3D modeling function, especially the high complexity modeling design [7]. It is applied to the design, assembly and interference inspection of the 3D solid parts of mechanical parts, and established to improve the efficiency of product design [8].

2.1. Overall design

The mechanical device mainly consists of six degrees of freedom robot, the X axis direction feed device (horizontal direction) and the Z axis direction feed device (vertical direction), with a total of 8 freedoms the whole slide table is located on the ground rail and connected with the slider by bolts, and the power source is supplied by the servo motor. The JHY640 robot is selected for the six-axis robot, and the rest is designed by itself. The device is shown in Figure 2 and figure 3.

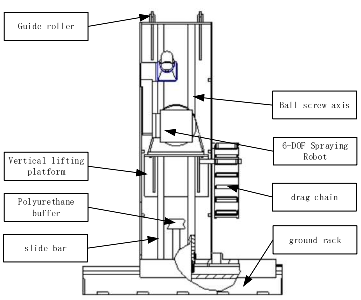


Figure 2. view diagram of sliding table

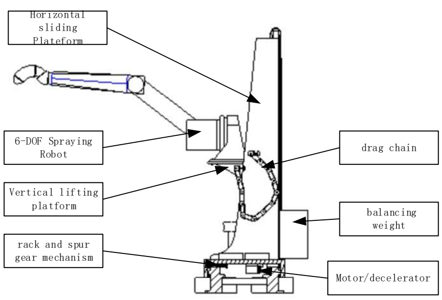


Figure 3. side view of sliding table

2.2. Design of lifting device

The spraying robot is fixed on the lifting platform by the bolt. The top of the sliding rod is connected with the slide bearing through the deep groove ball bearing. The bottom end of the sliding rod is connected with the slide bearing through the thrust ball bearing; the right hole is mounted with ball screw, and the top of the screw is connected to the slide bearing through the deep groove ball bearing. The bottom is connected with the slide table. The terminal is connected with the sliding table through the thrust ball bearing; the servo motor drives the lead screw to turn or reverse through the planetary reducer, so as to achieve the purpose of controlling the height of the lifting platform.

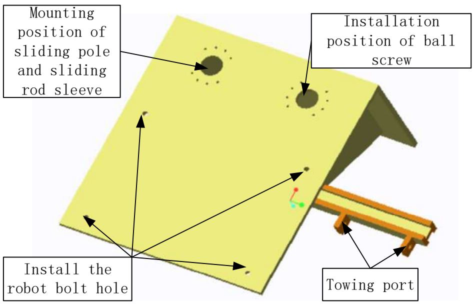


Figure 4. 3D sketch map

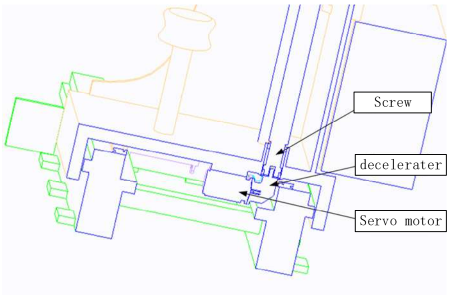


Figure 5. sketch map of 3D slide in slide table

2.3. Design of horizontal moving mechanism

Both the servo motor and the reducer are installed on the sliding table. The gear is mounted on the reducer and the rack mounted on the ground rail to form a gear and rack rolling pair. The slide table and the slider on the rack are connected by the bolt; in addition, the slide table is guided by the guide wheel. When the sliding platform needs to move in the horizontal direction, the servo motor receives the controller signal, turns or reverses, transfers the power source to the gear through the reducer, and realizes the accurate horizontal movement of the slide table. As shown in the picture

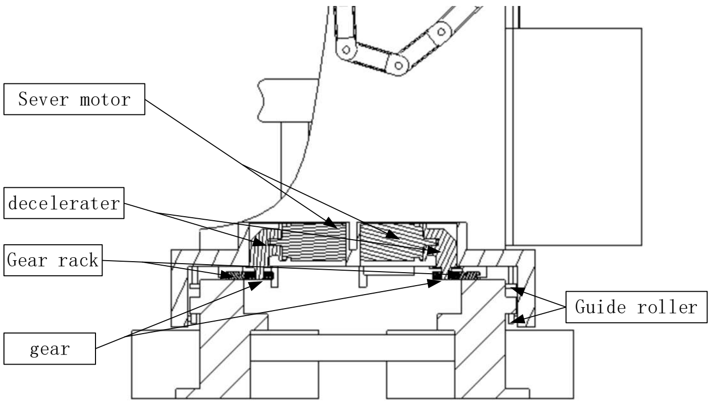


Figure 6. sliding table local sectional view

3. Simulation analysis

Finite element method (FEM) is a numerical solution to solve the problems of static and dynamic mechanical characteristics. It has the advantages of high precision, strong adaptability and standard calculation format. It is widely used in the fields of machinery, aerospace, automobile, ship and so on.

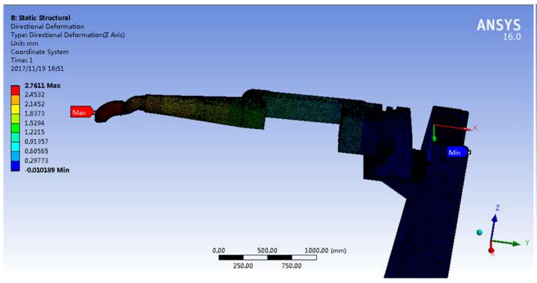
It has become an important tool in the design of modern mechanical products [9]; ANSYS software is based on the finite element theory has powerful linear and nonlinear analysis functions. The application of simulation analysis technology can shorten the design cycle of the product, save the cost, and become the preferred [10] of the designer.

3.1. Simplification of model

Model simplification: the slide table is mainly composed of the total support, the robot support, the sliding rod sleeve and the ball screw. On the basis of the closest actual working environment, the necessary parts and their assembly are simplified to reduce the amount of calculation; the bolt connection of the robot's support nut is ignored, the contact surface is selected as the combination, the sliding rod and the slide bar sleeve, and the slippery slip. The contact between the rod and the robot support, the slider and the sliding table is combined. At the same time, the stability of the overall structure of the sliding table is most affected when the ultimate position of the robot rises to the Z axis. (in the most extreme case, the bending moment of the horizontal extension of the mechanical arm is the maximum, and the knot is carried out in the most dangerous condition. The sliding table material is convenient to calculate and select structural steel; boundary conditions, constraints: in the static analysis, the ground of the sliding table is set as a fixed constraint; when the dynamic analysis is made, the ground is set to be frictionless; the load: the sliding table is subjected to gravity, the gravity acceleration is 10, the end actuator has been loaded well, no need. Load the other.

3.2. Static analysis

Calculation results



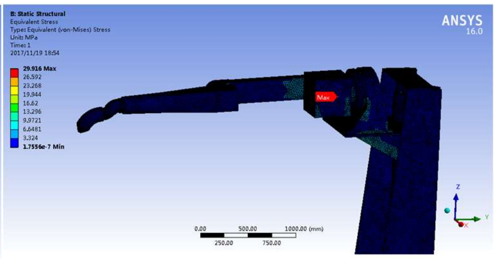


Figure 7. deformation and displacement. **Figure 8.** slipway stress cloud map

Figure 7 conclusion: when the robot is raised to the highest point, and when it is in the horizontal position, the bending moment of the manipulator is the largest, the deformation amount is the largest and the maximum deformation amount is about 2.76mm.

Figure 8 conclusion: the maximum value of stress diagram is 29.9MPa, which is far less than yield strength 255MPa, and the material can meet the strength requirement.

4. Kinetic analysis

Calculation results: when the data are measured at acceleration, a is measured when the force on the slide is 200N, and the displacement curve of the manipulator is measured in the vertical direction, as shown in the following figure.

Conclusion: when the robot arm rises to the maximum height of the sliding platform, the end of the arm will vibrate up and down during the acceleration process, and the vibration amplitude decreases with the time prolonging. In actual production, the mechanical arm should be avoided to the maximum height spraying work, and the acceleration state spraying should be avoided.

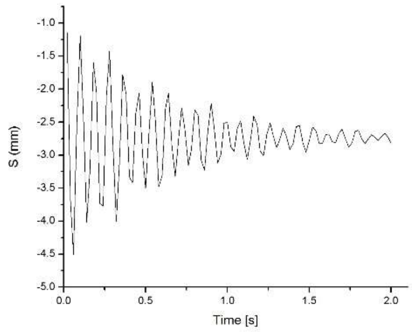


Figure 9. deformed vibration curve of endpoint in vertical direction

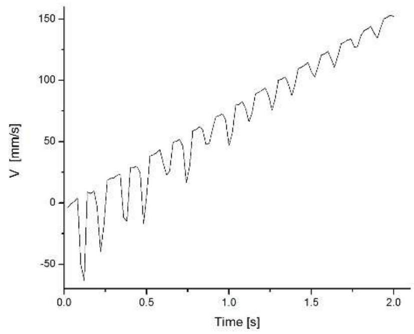


Figure 10. the V change curve of the end point in the horizontal direction

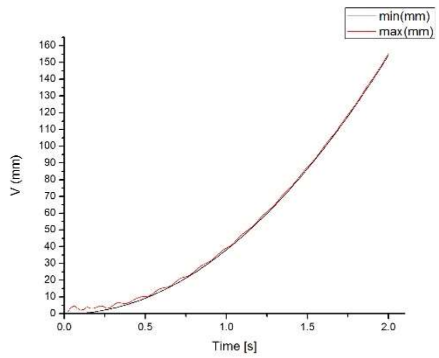


Figure 11. the V deformation curve of the slide table in the horizontal direction

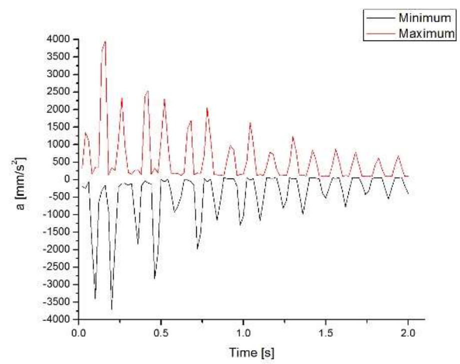


Figure 12. a vibration curve of the slide table in the horizontal direction

5. Conclusion

1) the fitting workspace shows that the moving slide can cover most of the body effectively. In the further analysis of trajectory planning, the arc edge of the roof should be paid attention to.

2) when the lifting device rises to the highest height, the maximum bending moment is produced by the manipulator level, the displacement of the end is 2.76mm, the deformation value fluctuates in the acceptable range of and the error compensation should be considered when assembling in the actual engineering.

3) when the device is speeded up, it can be concluded from the data that the end of the manipulator will also shake, and the acceleration time should also be avoided when spraying.

4) in the stress analysis, the maximum value of the calculation result is less than the allowable stress of the material.

5) the effectiveness of ANSYS workbench software in mechanism dynamics analysis and optimization design simulation is verified, which validates the reliability of the structure strength of the moving slide platform [10].

References

[1] Kuang Tao, Qin Sheng Sheng. Dynamic analysis of thrust bearing of hydraulic turbine based on ANSYS [J]. mechanical manufacturing and automation, 2015, (1): 38-41.

[2] Liu Wenjing, Song Xueliang, Jin Lan. Transient dynamics of cross beam structure of single girder overhead crane [J]. mechanical design and manufacturing engineering, 2016, 45 (11): 32-36.

IOP Conf. Series: Materials Science and Engineering **493** (2019) 012075 doi:10.1088/1757-899X/493/1/012075

[3] Aifaoui, N.,Deneux, D.,Benamara, A., etc. Mechanical analysis process modeling based on analysis features[A]. In IEEE International Conference on Systems, Man and Cybernetics[C], 2002; 6 pp. vol.3.
[4] Zheng Dengke, Yang Xiangdong, sun Zhou, etc. Pro/E based serial robot simulation platform design [J]. manufacturing automation, 2014, (14): 137-141.
[5] Liu Zhibo, Yu Hong Yun. Joint application of Pro/E, ADAMS and ANSYS in virtual design [J]. mechanical engineering and automation, 2008, (2): 48-50.
[6] Ji Youchang, Cheng Kai, Ju Haomin, etc. complex structure Pro/E model importing ANSYS problem research [J]. mechanical manufacturing and automation, 2009, 38 (3): 71-74.
[7] creo. https://baike.baidu.com/item/creo/6642952?fr=aladdin.
[8] Shen Bin, Ma Lianrong, Gong da. Parametric design technology of parts based on Pro/E's two development, [J]. mechanical design and manufacturing, 2007, (1): 40-42.
[9] Wang Guoqiang. Practical engineering numerical simulation technology and its practice on ANSYS [M]. Northwestern Polytechnical University press, 1999.
[10] Li Qianlong. Design and analysis of automatic spraying equipment for large workspace [D]. master, Beijing Jiaotong University 2014.