The Simulation Design of Wheeled Loading Maneuver Arm Based on ADAMS

Yuhuan Zhang [a], Liqiang Liu [b], and Xueping Cao [c]

Shandong University of Science and Technology, Qingdao 266590, China.

[a]1609953149@qq.com, [b]1059092508@qq.com, [c]1097347616@qq.com

Abstract

For the traditional design pattern of loader, the design cycle is long and the accuracy is low, and it is more expensive for manpower, material and financial resources. Solidworks and ADAMS is used to establish three-dimensional solid model of loader working device, change the assembly frame type to paranoid (x * t) import of complete model in ADAMS environment setting different STEP function, to complete the work device of the loader working condition of derrick structure lifting materials movement simulation. The unloading Angle of the working device is optimized and the design cycle is shortened.

Keywords

ADMAS; Loader. Virtual prototype; The simulation design.

1. Introduction

With the improvement of national construction scale, the demand for efficient and overloaded large engineering machinery is more and more big, with the upgrading of products, functional requirements for new products is also more and more high, shorten the design cycle is very important[1].

The loader is widely used in earthwork, especially in mining engineering, it can be used to shovel, transport and unload materials. Wheel loader in the traditional design patterns from the structure and function of parts, movement and force diagram and parsing, design low accuracy, computational complexity, it is difficult to know the whole process of the loader, not on the engine performance simulation analysis and optimization, and new product development cycle is long, the high cost of manufacture[2]. Combining with the virtual prototype technology, the virtual model of loader can be generated and the motion process of the simulation mechanism can be simulated, and various parameters of the mechanism can be quickly compared and analyzed. Compared with the traditional design method, the design efficiency and quality are greatly improved, and the trial production cost of the prototype is reduced by shortening the development cycle.

2. Establish a Working Device Model

ADAMS software is a powerful kinematics, dynamics analysis function, but its three-dimensional modeling function is relatively weak, difficult to establish a complex entity model. And the three dimensional modelling function of Solidworks is relatively strong, can accurately complete complex entity modeling and virtual assembly. And by using ADAMS and Solidworks data transmission interface, can be convenient to realize the establishment of the model and movement simulation.

Mainly by the bucket loader working device, movable arm, connecting rod, rocker arm, turning cylinder, and frame, movable arm cylinder under the working conditions of Solidworks model of parts, including the structure of the derrick choose veneer type curve shape, the shape of the bucket size by the beautiful and bucket volume into consideration, linkage design requirement for good translation; Good unloading property; Good dynamic performance; No motion interference. Since the shape of the frame and cylinder is less affected by the motion simulation, the frame is simplified to a rectangular body, and the cylinder is simplified as a cylinder and a hollow sleeve. Assemble the parts through various combinations, and save the assembly file as paranoid(x*t) format for easy import into ADAMS.

3.   The Simulation Analysis

3.1 Add Material Properties

In the working environment of ADAMS, the assembly model of paranoid(x*t) is imported, as shown in figure 1. By using the material database, adding material properties "Steel" to each part of the working device will automatically calculate the volume and quality of the model [3].
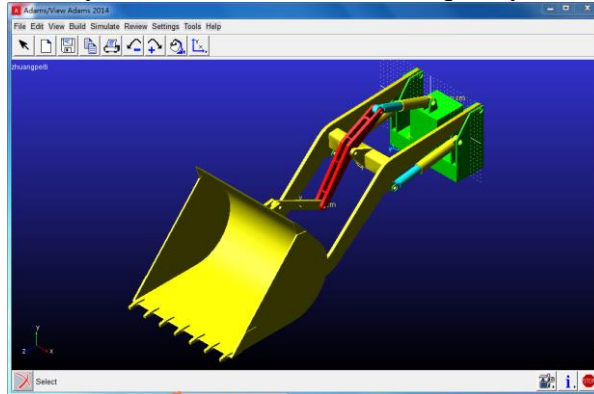

Fig 1. Working device

3.2 Add the Driver

According to the experience data of the typical working conditions of the loader, the rotary vice is added at the bucket and the movable arm, the bucket and the connecting rod, the connecting rod and the rocker arm, the rocker arm and the moving arm, the moving arm and the frame hinge[4]. Add a fixed pair of the earth to the frame. To make the symbol of the exercise pair more intuitive, click "Settings" on the menu bar - "Icons", and the "New Icon" bar is set to 0.2. Add mobile drive in the combination of two cylinder and piston rod.
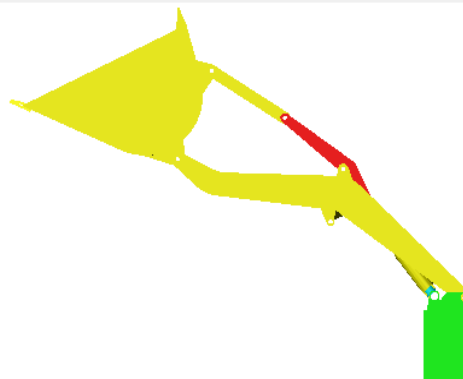

Fig 2. The simulation results

3.3 Added External Load

According to the working device to lift the load condition of the material, apply the biggest shovel to drag force1 on the tip of the bucket, and set the material gravity on the center of gravity of the bucket [5].

The expression of drag function is as follows:

STEP (time, 0, 158725.80, 2, 0)

The expression of material gravity function is:

STEP(time, 0, 4900, 2, 0)

Check the model without error, click the simulation button, set End Time for 2s, Steps for 50, click to run, and the working device will elevate the material to the highest point of work as shown in figure 2.

3.4 Motion Simulation

The figure 2 shows that the bucket discharge Angle is obviously unable to meet the job requirements, therefore, to eliminate motion interference of equipment will be rotating cylinder with a movable arm oil cylinder, and the movable arm hinged to the frame and rocker arm and arm hinged in add rotation drive, rotation speed is set to 45 ° / s, the simulation results as shown in figure 3, the discharging Angle meet the job requirements[6].
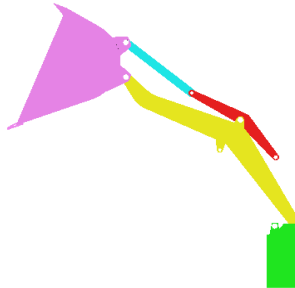
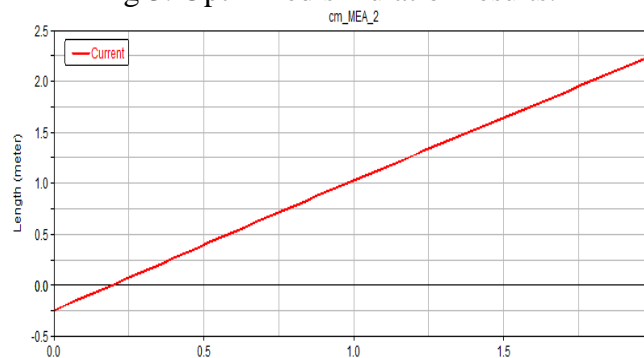Fig 3. Optimized simulation results.

Fig 4. Dipper center of mass y to displacement.

3.5 Simulation Result Measurement

The torque changes of the moving arm and the bucket hinge are measured, the velocity of the bucket mass center is changed with the acceleration and the displacement of the bucket center y, as shown in the figure 4.It is shown that the maximum unloading height of the bucket is 2.25m.

4. Conclusion

The results show that it is feasible to combine virtual prototype technology with control system simulation technology. The successful application of this method for the design of the loader provides a new way of thinking, but before the processing of physical prototype of mechanical system and control system is a combination of a comprehensive simulation and analysis of real fast, high quality and low cost design goal.

References

[1] J.H.Cheng: Engineering machinery general and tooling design(National defense machinery press),(2012) No. 06.
[2] L.L.Zhang,X.G.Zeng: The application of virtual prototype technology in loader design(Mining machinery),vol. 41(2013) No. 9,p.49-51.
[3] Z.H.Li: Modeling and simulation of virtual prototype of ZL50 wheel loader(Technological innovation and application),vol. 22(2014),p.4-5.
[4] X.M.Sha: Research on the development of wheel loader based on virtual prototype(Journal of nanjing institute of engineering),vol. 3 (2015) No. 13,p.26-30.
[5] Q.Zhang, F.Sun,J.F.Zheng,et al. Simulation of wheel loader based on AMESim and ADAMS(Machine tool and hydraulic),vol. 44 (2016),p.150-153.

[6] Kwangseok Oh and so on. Integrated wheel loader simulation model for improving performance and energy flow[J].Automation in construction.2015.58:129-143.