Motion Simulation Analysis of Two Degree of Freedom Robot Turntable

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Abstract

In this paper, the research of robot's two degrees of freedom motion simulation analysis is carried out. The 3D model of each component is created by Solidworks software and assembled.The virtual prototype model of robot turntable is created by using Adams software, and the simulation test is carried out.The simulation analysis of the pitch motion and rotation motion of the robot turntable is completed.The corresponding working characteristic curves are obtained, and the test results are studied.

Keywords

Robot, Carrying a turntable,Simulation analysis.

1. Introduction

At present, the research of small special mobile robots is booming. With the progress of technology and diversification of tasks, the research of small special mobile robots with strong functions has also become a new research hotspot [1-6]. The United States Remotec, Irobot and other companies launched a small robot Mini AndrosII, Packbot and other characteristics of the P.W. Allen; the British company also developed a small Vanguard EOD robot.Shanghai Univer small EOD robot is developed, which is also the enterprise cooperation and Northern robot developed robots.

In this paper, the design of a small mobile robot carrying turntable is simulated and analyzed.

2. Creating a three-dimensional model

2.1. Definition of solid model materials

The Solidworks parts database includes the friction coefficient, modulus of elasticity, Poisson's ratio, density and so on. In the default case, the material is made of aluminum, the designer can choose other materials in the material library, and can also enter the material characteristics by itself.

The way to define part material properties in Solidworks is to select a component after opening the assembly, then select Edit settings material, select material in the material catalog. The corresponding material properties are defined for the key components such as bushing, adjusting piece, connecting seat, tilt table and tilt table, so as to ensure the authenticity and accuracy of the next simulation.

2.2 Rigid body

First of all, we need to make some adjustments to the assembly relationship of the model, adjust it according to the relative motion relationship among the parts, adjust each motion unit to a part or a sub assembly, a sub assembly or a part is a rigid body.

2.3 Add constraints

In the Solidworks window environment, it is very convenient to add some simple constraints, which are mainly added to the rotating pair.

The turntable model of the mobile robot is transformed from the entity model to the function model through the above work, as shown in Figure 1 is the turntable model in Solidworks.
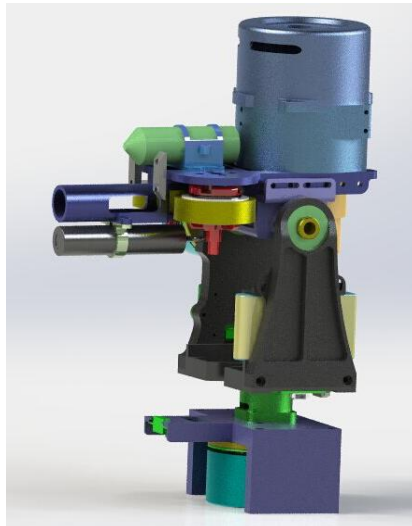
Figure 1 Turntable model in Solidworks

3.　The setting of the model in ADAMS

3.1 Introduction of three dimensional model

The 3D entity model of the mobile robot system built in Solidworks is imported into Adams, and the quality attributes are assigned to each part. The constraints in the constraint library are used to simulate the connections between components, and these relative constraints are used to restrict some relative movements between components. The model of the mobile robot system in Adams is shown in Figure 2.
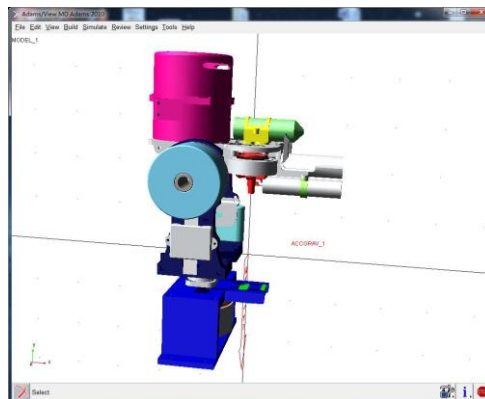
Fig. 2 Model diagram of robot turntable in Adams environment

3.2 Setting gravity and adding drive

For each of the parts with mass, the gravity point is at its center of mass. According to the model, the gravity should be taken as the negative direction of the Z axis according to the model coordinate system after the transfer.

According to the simulation requirements, the turntable model needs to add two drives, one for the rotating drive of the motor that drives the middle axis and the other for the pitching platform.

3.3 Check model

In order to ensure the smooth progress of simulation analysis, we should make a final inspection of the prototype model before removing the simulation errors, and eliminate the hidden errors in the modeling process.

Adams/View provides a powerful prototype model self-examination tool. Select the Tool ModelVerify command, start the model self check, complete the self check, the program displays the model self check information dialog box.

3.4 Setting up simulation analysis and creating measurement

In Adams, there are two kinds of simulation analysis output. One is the system default, and the other is user - defined.

According to the above two types of measurement, the user can choose according to their own needs; if the user needs to understand the specific information, and the default is not provided, the user is required to customize the measurement by Adams/View expression and function of Adams/Solver custom measurement.

The parameters of the motion and mechanical properties of the model can be obtained in Adams/view. The user can also define other output, such as pressure, work, momentum, and so on. Compared with the Adams/View preset output, setting out the output function provides a more flexible definition of the output method.

4. Simulation and result output

4.1 The simulation of the tilt of the turntable

The simulation time is 10s, the simulation step is 500 steps, the rotation drive Motion_2 is closed, and the pitch drive Motion_1 motion function is set as SIN (time*180d), as shown in Figure 3.

Fig. 3 Simulation setting of turntable pitching motion

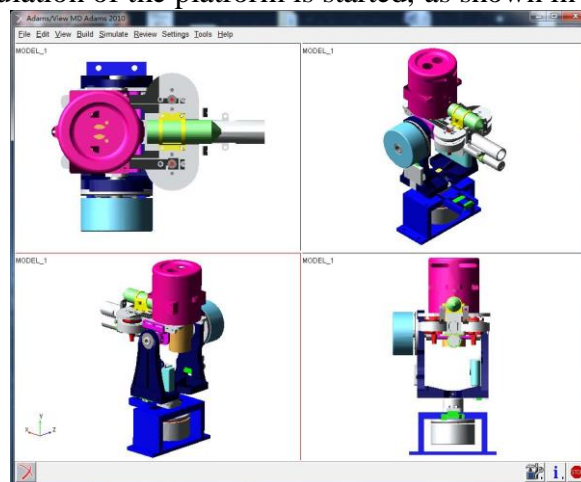Then the pitch motion simulation of the platform is started, as shown in Figure 4:

Fig. 4 Pitching movement

After the simulation is completed, the simulation results are saved, and the results are processed and output into the post-processing module. As shown in figures 5, 6, 7, and 8, the curves of pitch angle, angular velocity, angular acceleration and torque are shown respectively.
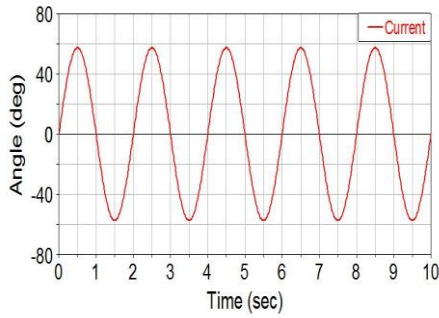
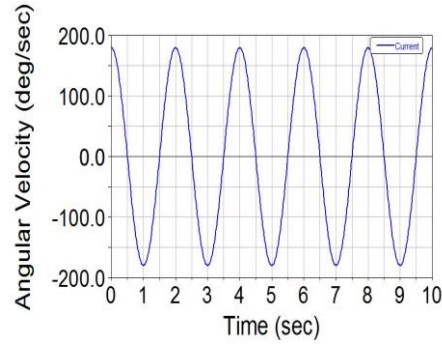Fig. 5 Change diagram of pitch angle   Fig. 6 The corner speed variation of pitch
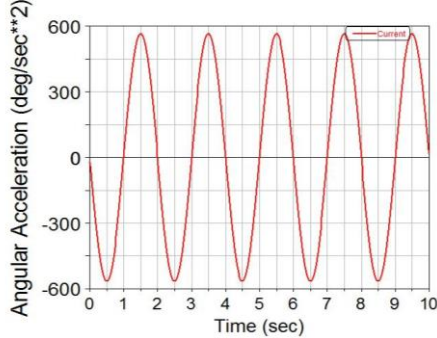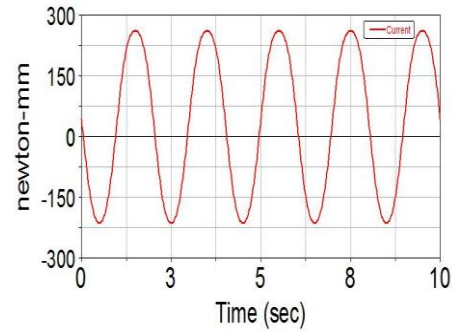

Fig. 7 A pitch acceleration change map   Fig. 8 Pitching torque change diagram

From the above simulation results, we can see that when the pitch angle of the pitching platform reaches the maximum, the acceleration reaches the maximum, and the driving torque reaches the maximum value at the same time, which also reaches the minimum value at the same time.

4.2 Simulation motion of turntable rotation

The simulation time is set to 10s, the number of simulation steps is 1000, and the rotation drive Motion_2 motion function is set as follows: 2*SIN (time*120d) as shown in Figure 9.
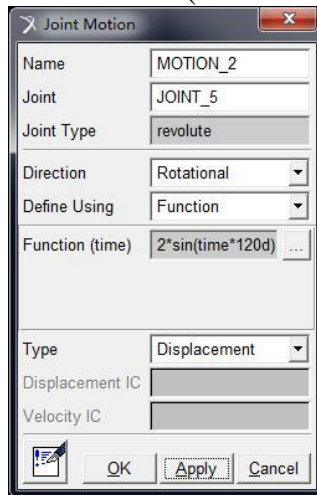

Fig. 9 Simulation setting of rotating motion of turntable

After the simulation is completed, the simulation results are saved, and the results are processed and output into the post-processing module. Figures 10, 11, 12 and 13 are the curves of rotation, speed and acceleration of the rotary table respectively.
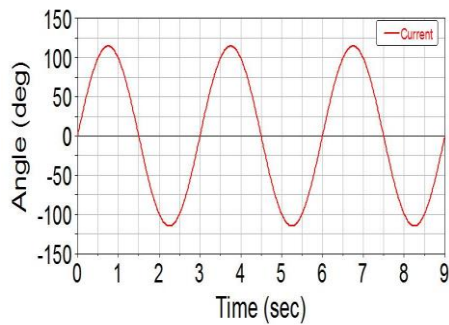
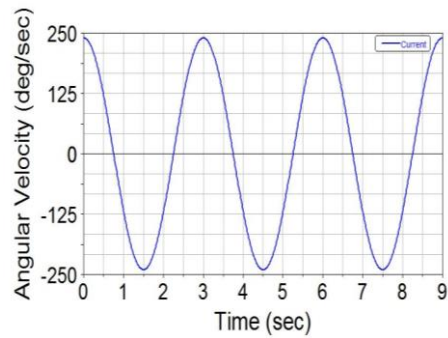Fig. 10 Revolving table angle change diagram

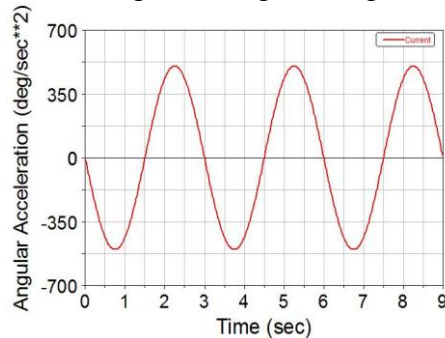Fig. 11 Change of rotation speed of the corner

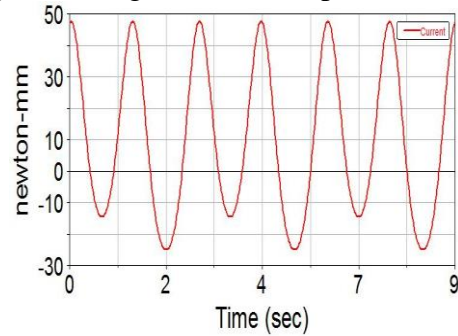Fig. 12 A rotation acceleration change map

Fig. 13 Revolving table torque change diagram

From the above simulation results, we can see that when the rotation angle of the no-load motion of the turntable is the largest, the acceleration reaches the maximum, and the driving torque reaches the maximum value at the same time, and they also reach the minimum value at the same time.

5. Conclusion

In this paper, the function model of the robot turntable is created in Solidworks, which has completed the work of defining the material of the entity model, creating the rigid body, adding the constraint and so on. Aiming at the design of the two degree of freedom pan tilt platform in Adams, a dynamic virtual prototyping model was established, and the simulation analysis of pitch motion and rotation motion was completed, providing data support for the development of physical prototype.

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