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LETTER TO THE EDITOR

Intelligent Control Method for Large Environmental Garbage Disposal Robot

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ABSTRACT: (Aiming at the problems of low efficiency, low automation and large manual construction for existing garbage trucks, an intelligent control method for large-scale environmental garbage disposal robots is proposed. Firstly, the kinematics and dynamics of the manipulator are analyzed. On this basis, the virtual simulation model of the manipulator is established by using ADAMS. Combined with the typical working conditions, the robot intelligently grabs the trash can and analyzes it. Corresponding parameters based on the analysis of the force, the simulation data was analyzed and studied. Based on the dynamic analysis and finite element analysis of the side-mounted garbage truck manipulator, the trajectory of the manipulator movement and the force analysis of each guide rail are obtained. Finally, the location of the stress concentration of the manipulator is obtained by combining the finite element analysis. According to the analysis results, the optimized design of the weight reduction of the manipulator is achieved on the basis of ensuring the strength.)

KEY WORDS: Garbage disposal; Mechanical arm; intelligent control; Stress analysis.

1 INTRODUCTION

With the acceleration of the pace of urbanization construction and the construction of urbanization civilization, the state and local governments have also introduced relevant policies to strengthen urban environmental protection construction, which also provides conditions for the rapid development of automatic garbage collection (Arnold et al. 2018). At present, China's existing garbage trucks have problems such as low efficiency, low automation, and large manual construction, which directly affects the construction of urban environment (Bertoni 2017). The foreign garbage truck realized a semi-automatic design, which can automatically grab the trash can and pour it into the garbage compartment, which truly achieves the intelligent garbage collection of the garbage truck. However, this puts higher requirements on the design of the garbage truck manipulator, and puts forward new requirements for the automatic identification of the trash can and the design of the strength and rigidity of the robot arm. Therefore, this paper analyzes and verifies the strength and stiffness of the manipulator while studying the intelligent parameter design of the multi-function manipulator of the side-loading garbage truck. Based on this, the structure optimization of the manipulator is carried out (Hassan et al. 2017, Islami et al. 2017, Ramyar and Zarghami 2017).

Xiaomeng Liu, Changxin Xu, Zhiguang Zhang, Yingquan Zhang, Shijun Wu published an article in the

journal Ekoloji's 2019 Issue 107 entitled "Study on the Role of Eco-environmental Impact Assessment in Performance Management Assessment of Large Water Conservancy Projects", this document can be used to maintain water resources, treat sewage, and make rational use of water resources through the supervision of large-scale water conservancy projects. Reasonable evaluation of construction project performance management is an important aspect of construction management. The ecological environmental impact assessment will have a positive or negative impact on the construction of water conservancy projects. Based on the analysis of the impact of ecological environmental impact assessment on project performance management, some suggestions and measures were put forward. Inspired by this article, the robotic arm is intelligently controlled through regulatory techniques to improve the garbage disposal efficiency of the garbage truck.

2 IDEA DESCRIPTION

2.1Advantages and disadvantages of existing garbage truck robots

At present, the urban garbage truck manipulator structure used at home and abroad mainly includes the articulated link type manipulator structure, the rail type manipulator structure, the lifting and turning barrel manipulator structure, the lifting and turning barrel manipulator structure, and the ladder track scissors supporting manipulator structure (Usui et al. 2017). As shown in Table 1, due to the structural characteristics of the robot itself, there are always some problems in the daily garbage collection process of the robot, which causes some inconvenience in the urban garbage collection work. Therefore, designing a garbage can automatically collect robots, which enables the entire garbage collection process to achieve intelligent garbage bins and automatic grabbing, is a necessary trend and requirements for the development of sanitation machinery.

Table 1 Advantages and Disadvantages of Existing Urban Garbage Truck Manipulators

Robot name	advantage	insufficient
Articulated link manipulator	Robotic automation is higher	The robot cannot independently adjust the relative position of the end claws and the trash can. The garbage can easily overflow during the dumping process, causing secondary pollution.
Rail type robot	Fast action and high automation	The robot cannot independently adjust the relative position of the end claws and the trash can. The garbage can easily overflow during the dumping process, causing secondary pollution.
Lifting bucket manipulator	Simple structure and good sealing	The degree of automation is low, relying on sanitation workers to hook up the trash can
Lifting bucket robot	Simple structure and good sealing	The degree of automation is low, relying on sanitation workers to hook up the trash can

2.2 Side-loading garbage truck manipulator finite element model

In the finite element analysis of the garbage truck manipulator, due to the responsibility of the manipulator structure

and the constraints of hydraulic and control functions, the overall structure cannot be accurately calculated. Therefore, in order to better perform the finite element analysis of the manipulator's force, the paper simplifies the structure of the garbage truck manipulator, does not consider the constraints of the hydraulic and control parts, and also simplifies some unrelated structures (Qiao and Gao 2017). The main force structure of the manipulator was analyzed and studied in detail, and the design rationality of strength and stiffness in the process of collecting garbage was analyzed. In the structure of the manipulator involved in the side-loading garbage truck, the front end gripper and the Y-direction of the robot arm are the main force-receiving parts. Therefore, in the establishment of the finite element model of the structure, the gripper and the machine for the trash. The arm conducts major research. In the paper, under the workbench software, the finite element simulation analysis of the established robot model is carried out.

2.3 Meshing

After the garbage truck manipulator model is built, it is imported into the workbench software, and the model is divided into grids before the force analysis is performed. In the sub-grid, since the front end of the manipulator and the mechanical arm structure can be summarized into a thin-walled and shell-unit model, the model is close to the actual structure, and the accuracy and convenience of the analysis can be achieved. Therefore, the mesh is divided by the shell unit on the gripper arm and the arm of the end face of the robot. Through the mesh division before the finite element stress analysis, the simplified mesh unit division diagram of the multi-function manipulator is obtained.

2.4 Load calculation and application

In the actual work of the garbage truck robot, each component needs to be integrated into a whole structure through a certain connection, such as welding, junction and riveting, etc. These joints can be effectively integrated by means of workbench software, according to the actual garbage truck operation has been pre-integrated with the various joints of the robot. In the normal operation of the robot arm, the force transmission between the arms is mainly borrowed from the slider body between the two, and the frictional force is affected at the place where it contacts, but in the finite element force analysis, The friction coefficient between the arms is relatively small and belongs to the range of small deflection. Therefore, a combination of degrees of freedom can be used to simulate the slider connection between the individual mobile phones.

2.5 Geometric modeling of the robot

In order to better analyze the motion law and force of the multi-functional manipulator of the side-mounted garbage truck, this paper uses the virtual prototyping technology based on ADAMS to calculate and analyze the process dynamics of the robot grabbing the trash can, and verify the designed side loading. Whether the multi-purpose robot of the garbage truck meets the design requirements.

ADAMS is one of the most widely used virtual prototyping analysis software in the world, and is currently the most mature simulation software for kinematics and dynamics simulation calculation. In addition, ADAMS simulation software provides a three-dimensional geometric modeling platform, but the platform's operability and modeling capabilities are not as convenient and powerful as traditional Solidworks, ProE and CATIA software. To meet the needs of more designers, ADAMS simulation software provides a variety of CAD model interfaces, including parasolid, STEP, IGES, SAT and DXF formats. The side-mounted garbage truck multi-function manipulator designed in this paper is a complex mechanical system. Although the tool of 3D geometric modeling is provided in the ADAMS software, the software function is relatively weak, and the modeling task for complex 3D models is not only It takes a lot of time to complete, and the dimensional accuracy and assembly position accuracy of the 3D model cannot be effectively guaranteed. Therefore, the modeling process of the multi-functional manipulator of the side-mounted garbage truck involved in this paper uses Solidworks software to convert and import the established prototype geometric model in the ADAMS/View environment, and add constraints and loads to finally perform

simulation analysis. Figure 1 is a virtual prototype model of a side-mounted garbage truck multi-function manipulator.

Figure 1 Virtual prototype model of side-mounted garbage truck manipulator

2.6 Applying dynamic constraints

In order to accurately analyze the dynamic characteristics of the manipulator, after completing the three-dimensional model of the side-mounted garbage truck multi-function manipulator, it is introduced into ADAMS, and the application of the mechanical power constraint is applied by applying the constraint module in the ADAMS simulation software to limit the major mechanisms of the robot. Relative movement. According to the trajectory characteristics of the model, the model has the following four types of constraints.

(1) Constraints of commonly used movement pairs, including rotary pair, slip pair, gear pair and fixed pair;

(2) The constraint of the specified direction, that is, the specified movement direction of each component during the garbage collection process by the robot, for example, the extension or contraction direction of the extension arm.

(3) The contact constraint mainly refers to a constraint of a contact process occurring during the movement of two members between the cam and the guide rod in the cam mechanism;

(4) Motion constraint mainly refers to the constraint of a component in the process of specifying a motion trajectory. For example, specifying a specific component to follow a certain STEP function motion.

3 RESULTS

Combined with the finite element analysis results of the above-mentioned multi-function manipulator under the three conditions of snatch, lift and dumping, the maximum stress and maximum strain of the multi-functional manipulator under various working conditions are obtained. The summary of the stress situation is as follows:

(1) By comparing the stress and strain analysis results under three working conditions, under the three working conditions, the maximum stress of the snatching condition appears in the vertical direction of the front hand gripper and the front end of the manipulator trash can. During the lifting process, the maximum stress occurs on the cross arm of the front end of the robot arm. In addition, there is a significant strain occurrence at the slider contact of the first arm and the second arm. In the dumping condition, the maximum strain of the manipulator occurs at the support of the robot arm and the rear end. In addition, the strain at the joint between the robot arm and the base also undergoes a large strain. In summary, under various working conditions, the position where the maximum strain occurs is the front end gripper of the robot, which appears at the front end of the trash can gripper.

(2) By comparing the force analysis of the finite element model under three working conditions, the position of stress concentration of the mechanical arm is most likely to occur at the joint between the various mechanical arms, and there is also a large concentration stress on the front bucket of the trash can. Therefore, in the case where the stress is concentrated or the structure is weak, corresponding measures should be taken, such as reinforcement rib

reinforcement or thickening treatment of the mechanical arm, to achieve the design requirements of structural strength and rigidity, and to avoid failure or damage of fatigue strength.

(3) In the actual work process, the garbage truck robot arm is constantly expanding and contracting, and the length is constantly changing. The length of the unwinding sleeve determines the force between the mechanical arm and the slider. The longer the mechanical arm extends, the horizontally for each mechanical arm. The greater the bending moment at the section, the lower the stress between the arms of each section. However, if the overlapping area between adjacent mechanical arms is too small, the dangerous section stress is likely to be excessively large. It can be concluded that the longer the mechanical arm protrudes, the more the stress is excessively concentrated in the adjacent section of the manipulator. It is also easier to create dangerous sections.

4 CONCLUSIONS

In this paper, the multi-function manipulator has been designed with parameters, kinematics analysis, optimization of the force analysis structure, etc., to achieve the optimal design of the manipulator. Based on the kinematics simulation, the force analysis model of the multi-functional manipulator was established by using the Workbench finite element analysis software. By analyzing the preparation of the previous period, such as the division of the grid, the calculation of the load and the application of the constraints. The stress and strain of the manipulator under different loads were studied under the conditions of snatching moment, lifting process and dumping process. The stress distribution characteristics of the manipulator's overall model were obtained, which provided an important basis for subsequent structural optimization.

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