Suspension Structure Research about Omni-directional Mobile Platform Based on Mecanum Wheel

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Abstract

This paper mainly designs and researches the omni-directional mobile platform suspension structure based on Mecanum Wheel[1].Through the analysis of the three suspensions, the coil spring suspension scheme was mainly studied to improve the smoothness of the omnidirectional mobile platform. In order to prevent the jamming of the coil spring, a spring stuck prevention device is designed according to the reference data to ensure the smoothness during its operation.

Keywords

Mecanum wheel; spiral spring suspension; spring suspension stuck prevention device.

1. Preface

The omnidirectional mobile platform needs to adapt to different road surfaces during the work process. The uneven road surface will impact the Omni-directional wheel of the mobile platform. Under the condition that the Meconium wheel and the mobile platform are rigidly connected, the platform will generate large vibrations. This leads to a decrease in the stability of the entire delivery system. At the same time, the Omni-directional mobile platform has a greater inertia during load operation, which has caused the overall excitement of the platform to decline [2]. Therefore, it is necessary to design a suspension system to establish an elastic link between the Meconium wheel and the platform.

2. Suspension Design Schemes

2.1 Integral Bridge Suspension

As shown in figure 1, n the basis of not changing the front wheel system of the omni-directional mobile platform, the rear wheel shaft is connected with the integral crossbar, which is the bridge body of the rear wheel. A rotating pair is added between the body of the bridge and the moving platform, and the axis of rotation is perpendicular to the rear wheel axis and parallel to the ground.

The overall bridge suspension system is a kind of structure which is widely used in the early stage of heavy load transportation, and belongs to non-independent suspension. Its advantage is mainly embodied in due to the increased between two rounds of the bridge, not only increased the integrity between the gear train of body makes the whole transport platform more secure, also make the whole transport platform significantly improved its load capacity. But at the same time the overall bridge suspension has some deficiencies, such as being the bridge connecting the two limited omni-directional wheel vertical movement, in case of large obstacles and low-lying road, omnidirectional mobile platform of motor performance is still not very ideal, and unilateral omni-directional wheel games affect on the other side of the omni-directional wheel, vertical displacement in the process of moving platform is volatile, the steady performance of the structure body is generally.

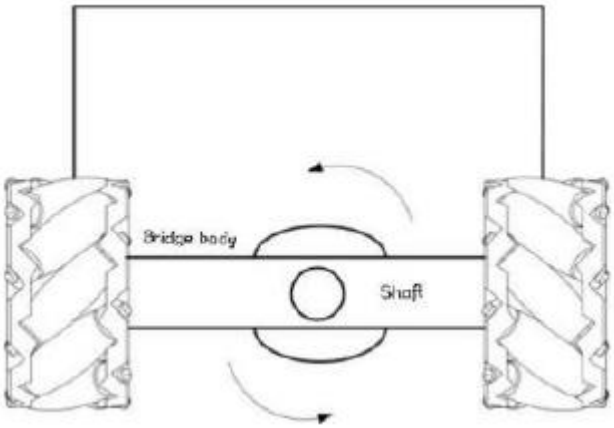

Fig 1.Integral bridge suspension Schematic

2.2 Oil and Gas Suspension

The commonly used suspension system in the transportation field is oil and gas suspension. The oil and gas suspension system is divided into single gas chamber oil and gas suspension, dual gas chamber oil and gas suspension and adjustable oil and gas suspension. Oil-gas suspension is usually by an elastic medium such as inert gas and a power transmission medium such as oil, it USES air pressure after the characteristics of smaller volume, absorb the impact energy, not only has good nonlinear variable damping characteristics can satisfy the requirement of the mobile platform complex road conditions to adapt to, and has a good vibration damping performance. The energy storage ratio of oil and gas suspension is also very large, with 6MPa nitrogen gas pressure as an example, the energy storage ratio is about 330000 N·m/kg. Suspension due to the use of oil and gas oil as medium, surface movement by low friction loss and long service life, the compressibility of oil itself is small, makes the suspension can realize atresia rigidity, load a larger load task, at the same time, the oil and gas suspension to smaller volume and its quality relative to other suspension is lighter, can simplify the structure arrangement and seriation design can achieve the system, thus have great potential for development [3].

On the omni-directional mobile platform, the four Mecanum wheels [4] are connected separately to the platform, so the independent oil and gas suspension is adopted, as shown in figure 2. Designed so that when any one of the wheels are the benefits of moving to the uneven road surface impact, the wheel will be relative to the mobile platform to beat to mitigate the impact of role, the other three wheels are not affected. This kind of structure has strong independence, which can provide reference for the future development of multi-wheel platform structure. However, there are some problems in the oil and gas suspension. Due to their own structural characteristics, they can only bear the load in a single direction, and have higher sealing requirements, and the maintenance and replacement are more troublesome. There are more parts for oil and gas suspension, and the cost is slightly higher.

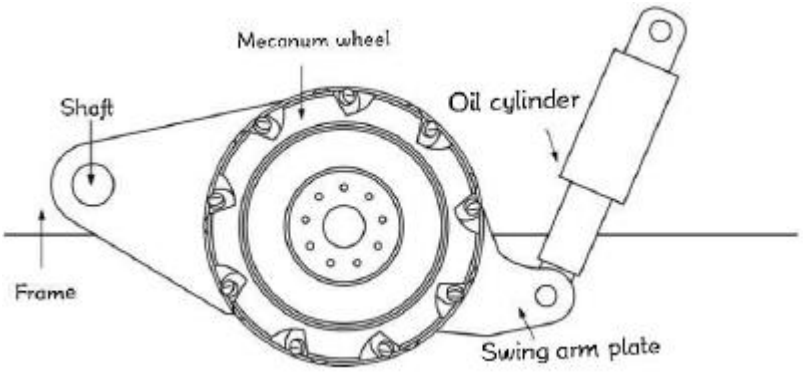

Fig 2. Oil and gas suspension schematic

2.3 Spiral Spring Supension

Spiral spring is a common unit elasticity and install vertical helical spring between the omni-directional wheel and the mobile platform, not only can be produced by the uneven road surface excitation kinetic energy is converted into elastic potential energy, have buffer action. The energy storage ratio of spiral spring unit mass is about 180-280 n·m/kg, and its monomers have small space and small mass, which is conducive to the layout of the internal space of the mobile platform 5].

Type spring suspension has some problems, although its structure can be done to lessen the impact, but vibration reduction ability is limited, but the vibration reduction of omnidirectional light load mobile platform is not particularly demanding system is enough to completely meet the use requirements. The spring is easy to contact with the center connecting rod when the compression change is large, and the card dies, causing the rebound to be blocked, and the anti-card dead device can be added to meet the light load requirements, as shown in figure 3.

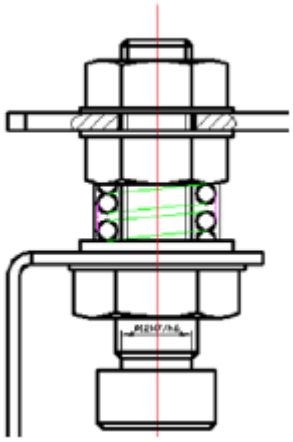

Fig 3. Spiral spring schematic

3. Spring Suspension Stuck Prevention Device

Using spiral spring suspension device, it is easy to get stuck when the spring is compressed. To solve this problem, a device is designed as shown in figure 4, and a physical installation diagram is shown in figure 5. It can effectively prevent the occurrence of stuck.

Fig 4.3D model

Fig 5.Physical installation diagram

4. The Design Principle o Omni-Directional Mobile Platform Frame

The overall structural design of the omni-directional mobile AGV requires simple and reliable, and meets its functional requirements, that is, not only meets the performance requirements when the omnidirectional vehicle is running and accelerating at a uniform speed, but also minimizes the quality of each component. In order not to increase the extra burden that the car body can carry, the main bearing weight of the omnidirectional car comes from the carrier, the motor, the AGV's own weight, and the extra load of the actuator.

The all-round mobile AGV adopts a symmetrically-arranged structure, consisting of four Mecanum wheels, four servo motors driven independently, springs with shock-absorbing functions, and a frame made of steel plate, in which Mecanum wheels (driving wheels) are installed symmetrically. They are arranged on both sides of the centerline of the car body. Each drive wheel assembly contains a servomotor. The chassis of the vehicle is made of 3mm thick steel plate.

The overall exterior design of the omnidirectional vehicle cannot be neglected. It facilitates the disassembly, assembly and maintenance of the control system and the power supply device lines. In addition, the car body profile should be free of sharp corners and protrusions, which can effectively avoid collisions with other objects. The omnidirectional vehicle body has four motors, four batteries, a battery charger, and wireless remote control receivers. The configuration is designed and installed on the body frame to ensure the relative stability between the omnidirectional vehicle and the vehicle body.

5. Omni-Directional Platform Frame Loading Form

The transportation platform is divided into two major categories in terms of bearing mode and structure: non-loaded body and full-loaded body. The full-bodied body structure, also known as Unibody, is a rigid monolith welded directly from formed steel beams and stamped sheet metal parts. There is no rigid frame, so the overall quality is low and the internal space utilization is high. The entire load-bearing body is mainly subjected to various load forces during operation. Therefore, this type of vehicle body has excellent performance in terms of stability, but the chassis strength is far inferior to the non-bearing type body, and the overall load capacity is relatively limited. Non-loaded body, also known as Full Frame, is characterized by a rigid frame. Its overall structure can be seen as the body and motor drive systems are directly attached to the bottom frame girder through the mounting bracket. This kind of car body is characterized by low space utilization, but the chassis

structure has high strength, good resistance to bumps, and strong bearing capacity. In a comprehensive analysis, the omnidirectional mobile AGV platform uses a non-loaded body structure.

6. Assembly of 3D and 2D Drawings

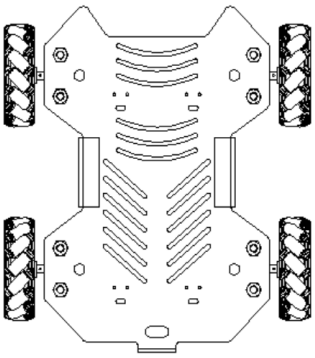

Fig 6.Two-dimensional diagram

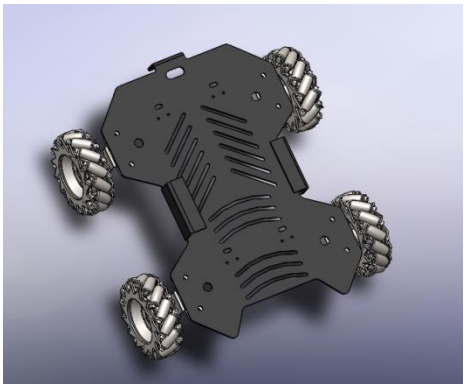

Fig 7. Three-dimensional diagram

7. Conclusion

In view of the problem of large inertia and weak stability of the platform movement, the design of suspension structure is discussed in detail. Good suspension system not only can have an underground uneven road surface and improve the road friendliness of the mobile platform, through sex and stability, but also can reduce platform department's wheel assembly when possible flatness deviation.

The frame of the omni-directional mobile platform was designed. First, the overall loading pattern of the frame was analyzed, the frame structure and design principles were determined, and the main parameters of the frame were determined. At the same time, it is ensured that the all-around mobile AGV can continue to run smoothly at the maximum speed, and it also needs to satisfy the extra power required for the start-up and acceleration of the car body.

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