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Research On Motion Characteristics Of An Adaptive Robot At Bent Pipes

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***Abstract*—In this work, a robot is designed to adapt to changes in bent pipes. The robot can automatically adjust the speed of each driving wheel according to the environment of bent pipe, so as to improve the flexibility of the robot when it passes through bent pipes. The motion characteristics of the adaptive robot are analyzed by establishing the three-dimensional model of robot in the pipe. The results show that the robot has good motion characteristics in the bent pipe and can adapt to the application in the engineering pipe.**

Keywords—adaptive robot; bent pipe; motion characteristics

I. INTRODUCTION

Pipeline is widely used in the transportation of oil, gas and other fluids because of its economy and convenience. However, with the increase of its use time, it will inevitably appear aging, corrosion and other external damage caused by various factors, if not timely maintenance, may cause serious safety accidents. Pipeline robot is a mechatronics system that carries sensors or operating devices and can walk along the pipeline autonomously to carry out pipeline inspection and repair operations in harsh pipe environment. Wheeled robots have many advantages such as fast walking speed, large towing power and simple structure, which is widely used in the industrial field [1-2]. However, when the wheeled pipeline robot passes through the bent pipe, the speed of each driving wheel is different due to the different arc lengths of each driving wheel. If the wheeled pipeline robot does not have differential function, the effective towing power of the robot will be reduced, the wear of transmission parts will be aggravated, and the performance of the robot will be reduced [3-5]. In this paper, an adaptive pipeline robot is designed, which adopts the motion mode of front wheel drive and rear wheel auxiliary support. In order to analyze the difference of the robot passing through the bent pipe, an accurate pose model of the robot running in the bent pipe is established, and then the motion characteristics of the robot in the bent pipe are analyzed.

II. MODEL

A. Geometric structure model of robot

Fig.1 shows the structure schematic diagram of robot. The robot is designed with modular concept, that is, the robot is divided into power mechanism, walking mechanism, auxiliary support mechanism and so on

according to the use function, and this study only analyzes the walking mechanism of the robot. As shown in Fig. 1, the robot is equipped with 3 rollers at equal spacing in the same circumferential direction, and each robot has 6 rollers in total to complete the moving motion. In order to clearly analyze the motion characteristics of robot, the motion analysis of two robots in series are carried out in this work.

Fig. 2 shows the 3D model of motion simulation. The diameter of the smooth pipe is 386mm, and the inner and outer radii of the curved part of pipe are 270mm and 410mm respectively. The NX12.0 software is used to simulate the motion characteristics of the robot. The movement speed of robot is set as 400mm/s during the simulation.

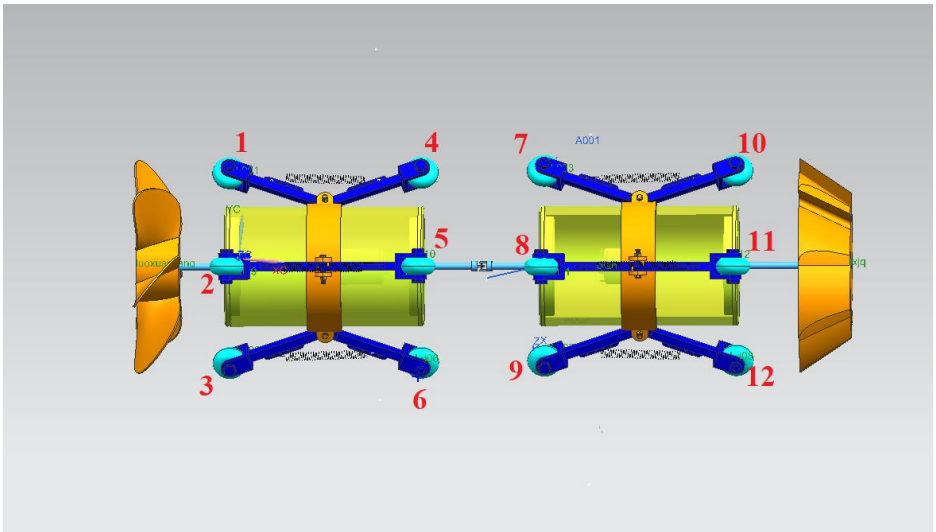

Fig.1. Structure schematic diagram of robot

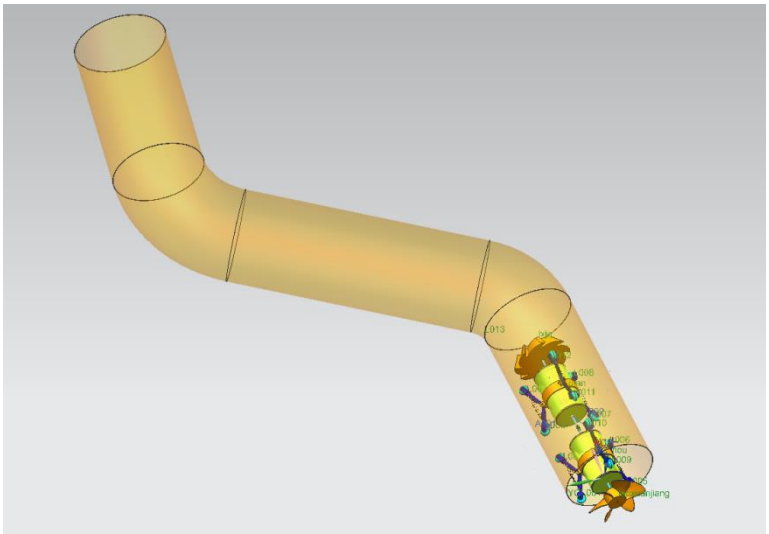

Fig.2. 3D model of motion simulation

III. RESULTS AND DISCUSSIONS

Fig.3 shows the comparative analysis of wheel speed. As shown in Fig. 3(a), it can be found that the speed of No. 1 and No. 3 wheels changed at 2.5 and 12.5 seconds, this is mainly due to the robot entering the bent pipe. In addition, the speed of No.1 and No.3 wheels changes in opposite trends at 2.5 and 12.5 seconds. Obviously, this is caused by

the difference in radius of the inner and outer arc of the bent pipe. Similarly, it is clear that No.10 and No.12 wheels also showed opposite trends. However, the speed of No.10 and No.12 wheels changes more sharply than that of the wheels of No.1 and No.3. This may have been caused by the sliding of No.10 and No.12 wheels.

To sum up, the robot can pass through the bent pipe smoothly, which indicates that the robot has strong adaptability to the pipe environment. However, the difference between the speed of the front and back wheels of the robot still needs further study and structural improvement.

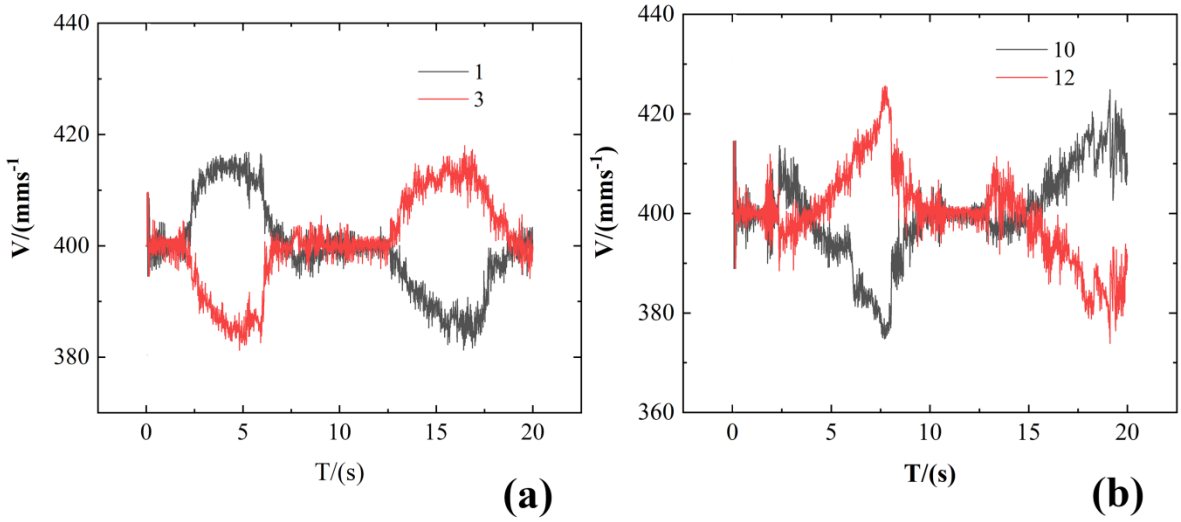

Fig.3. Comparative analysis of wheel speed

IV. CONCLUSIONS

In this work, the motion characteristics of an adaptive at bent pipes are analyzed by using simulation. According to the simulation analysis, the robot can adapt to the change of pipe environment and realize the differential effect of inside and outside radius of bent pipe.

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