Low-Power 80W Energy-Saving Robot which can collaborate with human safety and comfortably





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1. Overview

The robot uses a constant gravity compensation structure with springs to constantly balance the robot at all times, no matter the position the robot takes. This made it possible to use and under 80W motor, which is considered to be the standard of intrinsically safe power sources, to transport parts up to 25kg. In addition, the development of technology which can controls the robot flexibly and detect wherever human contact with the robot, improves the safety of the robot. This increases the comfort level of human working together with the robot, and created a low power 80W energy-saving robot which can collaborate safety and comfortably with human.

2. Technical Details

The overall structure of this robot is shown in Fig 1. This spare tire automatic installation robot was achieved by bringing together a constant gravity compensation structure using springs and 80W motor. This is a low output hybrid drive mechanism. To keep the structure simple, an automatic compensation structure was only included in the elevating device, and different from a SCARA robot, the elevating axis is located in the base. In addition, the elevating axis uses a parallel link mechanism as shown in Fig 2. so that the hand does not lean due to rising up. Therefore, no matter what position the horizontally moving hand, second axis, third axis and pinch revolving axis take, gravitational momentum will not be placed on the horizontally revolving axis so that a motor rated at 80W or less can be used to move all axis. This made is possible to create a highly durable and simple weight compensation mechanism.

Constructing the robot using a 80W or less rated motor made the robot be excluded from being applied to the separation regulations required between people and industrial robots in the Industrial Safety and Health Law and Ordinance on Labor Safety and Health. However, in order to further increase safety and the sense of security of workers when working near the robot, a power sensorless flexible drive has been developed as an additional protective measure.

The external force is based on the dynamic model for the arm and is extrapolated from the calculated motor load current of the drive shaft torque and angular speed and angular acceleration of the various axis. The external force can be detected no matter where the arm is because drive shaft torque of the foundation is used, and this makes it possible to eliminate blind spots when using the visual sensor and power sensor. The load current measurement feature already installed in the servo amp is used, so no new sensor is required. Moreover, this calculated external force is used in the impedance control, so even if the robot makes contact with a person, it is possible to stop the robot with less than 70N contact force applied to the person. (Fig 3.)

One of the features of the robot is the fact that the robot is controlled in such a way that excessive reactive force will not be applied by a positional error when there is an impact or something is caught in between the robot by using the virtual conveyor feature that moves at a specified speed thanks to the virtual dynamic feature of the impedance control. This made it possible to achieve a robot with flexible control that both moves and stops safely.

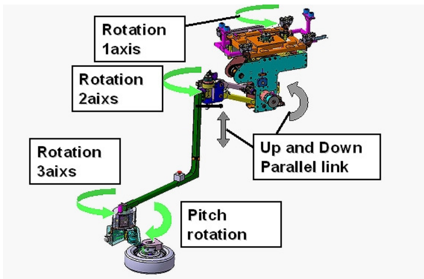

Fig.1 Mechanical structure of robot

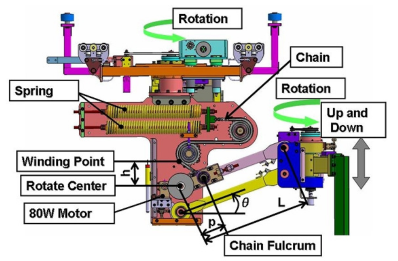

Fig.2 Hybrid mechanism by motor and gravity compensation structure

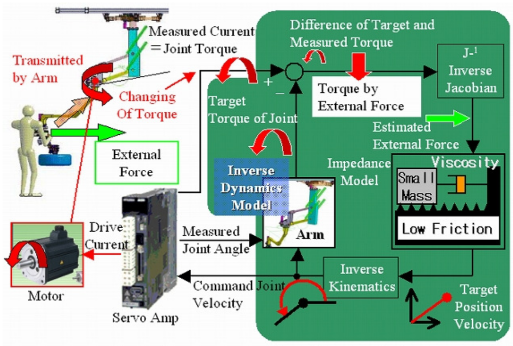

Fig. 3 Force sensorless impedance control

3. Summary

This is the first robot which can collaborate with human safety and comfortably by using low output drive and flexible control. It has the potential to make a significant contribution to expanding the realm where robots can be used in production lines, and this robot is expected to create a production environment where workers can work safely and comfortably.

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