Development of Dual-arm Robot MOTOMAN-SDA20D


Takashi Sanada*1
(Born in 1968)


Manabu Okahiha*2
(Born in 1967


Kazuhiro Fukudome*2
(Born in 1972)


Shinzi Murai*2
(Born in 1963)

1. Abstract

Currently, the industrial robot is adopted as an efficient automation tool to the applications such as arc welding, spot welding, and painting mainly in the automobile industry. For the future, it is highly needed and expected as an efficient tool for automation at the fields of commodity distribution and assembling which have a lot of manual work processes.

Therefore, we have developed this dual-arm robot MOTOMAN-SDA20D which is optimized to these usages. This robot aimed for the realization of the flexible equipment equivalent to humans by extending and improving the robot's motion performance based on the concept of robotization by the human-like space and tool to re-create human-like movements. Keywords are the 7-axis arm structure and the dual-arm structure. The arm structure adopts 7 joints in order to obtain the flexible movement, and we newly developed a small actuator for these joint sections. Also, the dual-arm structure was designed to be equipped at the work area equivalent to the current situation by keeping 2 arms and the rotation axis (waist axis) compact.

2. Content of Technology

The arm structure of this robot consists of 7 joints and simple arms without offset. Compared with the traditional arm structure, the added 1 axis improved its flexibility. Therefore it enabled the wraparound operation (Figure 1), which could not be realized with the 6-axis structure, and the detailed avoidance operation of arm interferences. This was achieved by the added single degree of freedom which enables the same controls as the movement of human elbow and operates only the arm with keeping the position (posture) of the tool head as it is. The features of the dual-arm structure are the followings: (1) Grasping function by the dual-arm (2) Flexible changing of the ways to hold the workpiece with the dual-arm (3) Equivalent space to human size and work (4) Equivalent motion performance to humans.

In order to realize these features, downsizing the joint sections was the top-priority issue for this robot development. Traditionally, the power structure including a motor, speed reducer, encoder, and break was embedded in the joint section of the robot and it occupied the large capacity. Therefore, if this arm structure type robot was tried to be developed with the traditional power structure, the joint parts would be large and the interference of each joint would increase, and it could not realize the less-asperity arm shape like human arm, the arm dimension, and the required motion range. To solve this problem, we developed a hollow downsized power structure (actuator) which integrates the motor, speed reducer, encoder, and break (Figure 2). By embedding it in the robot's joint sections, no wiring and piping around the outside of the arm is needed. Also it does not interfere with peripheral devices, so the shape and movements like human upper body has achieved. For this actuator, we reflected the specifications of manipulator request with consideration for usability. Specifically, the acceleration performance and shape were optimized. For the optimization of shape, we streamlined the robot to make it closer to the human upper body, and flattened it by shortening the overall length of actuators located at the joint sections of the robot in order to minimize the changes of the working environment now occupied by humans. This actuator was made into a series and developed as a module. Figure 3 shows the external view of the dual-arm robot SDA20D which was developed to streamline the dual-arm robot by optimizing the actuator.

3. Summary

The robot developed this time is adopted for assembling and commodity distribution fields. The assembling field is extremely wide, and for the situation of automobile manufacturing for example, there are a wide range of processes such as from the main process like final assembling of the vehicle bodies to the sub assembling. As can be seen from the production processes of vehicle basic units such as engines and transmissions and small module products obtained from outside, there are considerable processes by human works.

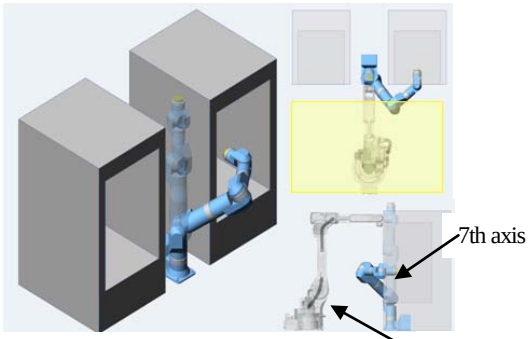

Figure 1: 7-axis Wraparound Operation

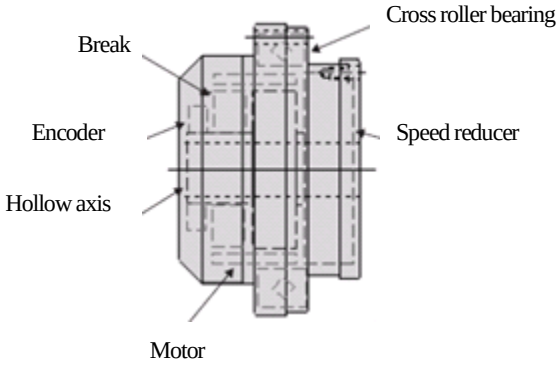

Figure 2: Downsized Power


Figure 3: External View of SDA20D

If the robot itself evolves to re-create the human workability, it will open up the possibility of expanding the robot to various processes and manufacturing industries with common technologies.

This commodity distribution field is intended to "parts allocation", "transferring between processes", and "parts setting process". Though parts allocation and classification works and transportation between processes are simple tasks, they handle many kinds and types of parts, and there are situational ancillary tasks such as replacement of stages. Therefore, many cases are dependent on manual labor. They are not automated except for the dedicated processes, because they are judged even if only the simple task fields can be automated there are few advantages to automate the ancillary tasks if some of them remain as manual labor tasks.

From the aspect of extra values of the works, there are great needs for automation, so the versatile workability of the robot equivalent to manual works can be expected to be realized.

*1 Regular member, YASKAWA ELECTRIC CORPRATION
*2 YASKAWA ELECTRIC CORPRATION