Advantages of electric grippers compared to pneumatic solutions

Grippers are used as end effectors for robots and other automatic machines (Fig. 1) and can be divided into pneumatic and motorised grippers. Pneumatic grippers are light, inexpensive and easy to operate, but precise adjustment of gripping force and speed is difficult. Electric grippers, on the other hand, allow the user to adjust the gripping force, speed and position to the workpiece. This not only prevents abrupt impact with the workpiece, but gripping force and cycle time are also optimised. The motor position can be used to determine whether a workpiece is present and to check its dimensions. In the electric gripper of the EH series, the so-called AZ motor from Oriental Motor serves as the drive and is combined with a gripper and rack and pinion mechanism. The main advantage is that the gripping force can be adjusted.

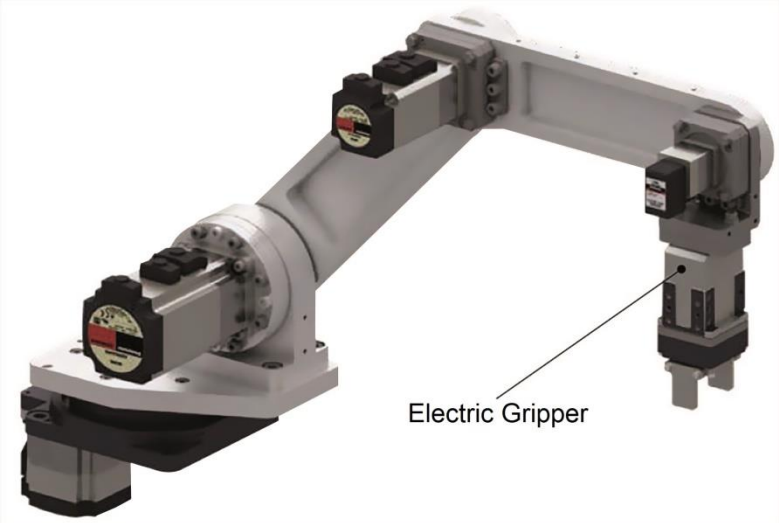

Fig. 1: Arm robot with electric gripper as end effector.

Even though pneumatic grippers are often used in pick & place applications, these grippers reach their limits when it comes to gently gripping workpieces with low rigidity. This is precisely where electric grippers unfold their advantages. With the EH Series, for example, no additional sensors are required to determine the end point of the gripping process or to measure the workpiece; these processes are fully automated. In addition, the DC power supply makes the EH gripper ideal for use in battery-powered devices such as automated guided vehicles (AGVs) or mobile robots.

Fig. 2: Oriental Motor's EH Series electric gripper.

Structure

A gripper design can be implemented mechanically in various ways, e.g. with a worm gear, cam and spindle or rack and pinion mechanism. The EH Series uses the latter for high transmission efficiency and continuous gripping force. The combination with a 28 mm motor keeps the dimensions of the gripper small (Fig. 3).

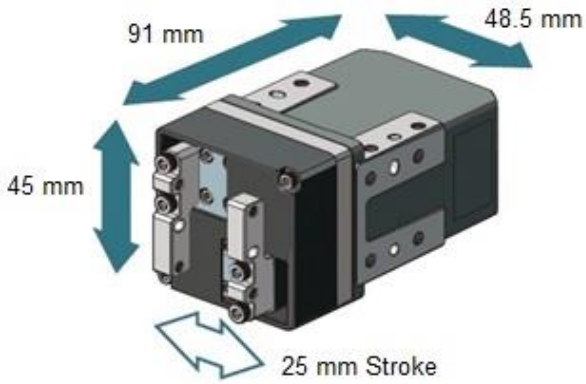

Fig. 3: Compact dimensions with 25 mm stroke (12.5 mm per side).

The stroke is 25 mm, so that workpieces with different formats can also be gripped up to this distance without having to change the fingers. Thanks to optimal lubrication, the gripper was able to operate 20 million gripping operations without any problems at full gripping force in tests.

Motor

The motor is an AZ Series motor with a multiturn absolute sensor (ABZO sensor, see Fig. 4). In the event of a power failure, the ABZO sensor mechanically retains the position information and allows the machine to continue operation without homing. This eliminates the need for an external switch for homing and reduces the expense of design, wiring and adjustment.

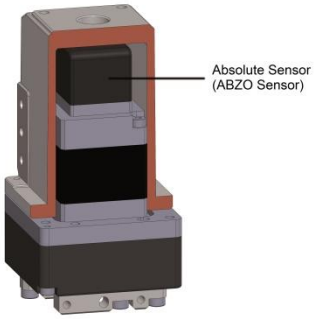

Fig. 4: The AZ motor with absolute sensor is used as drive.

Features

Gripping force

With pneumatic grippers, the regulation of the gripping force is done with the help of a pressure gauge via a pressure reducing valve, fine adjustment is difficult here. The air pressure loss depends on the length and inner diameter of the line from the compressor to the regulator as well as on the ambient temperature and must be readjusted if these conditions change.

The EH Series applies continuous pressure to the workpiece and the motor current can be set in 1% steps relative to the maximum value - the possibility of fine adjustment is thus given here.

The low-loss rack and pinion mechanism ensures a stable gripping force regardless of the ambient temperature. In addition, the length of the connecting cable has no negative effect on the gripping force thanks to the constant current drive of the driver.

Speed

Pneumatic grippers regulate the opening and closing of the fingers by changing the amount of air, but this is not without problems. This is because the air reacts to pressure and temperature fluctuations by expanding or contracting, which can have a detrimental effect on speed stability and control.
In contrast, the EH gripper convinces with high reliability thanks to the motor drive: speed, acceleration and travel distance of the fingers can be precisely adjusted, the cycle time calculated.

Shortening the cycle time

In pneumatic grippers, gripping force and speed are adjusted by varying the air pressure and air flow rate, which influence each other and are difficult to adjust independently. Furthermore, it is not easy to change the flow rate and speed during operation. When the air flow is switched from the controller to the gripper by opening and closing the solenoid valve, there is a delay of 10 ms or more from the energisation of the solenoid valve to the start of finger movement. This means that the fingers open and close faster but take more time to complete the gripping process. Figure 5 shows the comparison of cycle time between a pneumatic gripper and the EH Series with the same travel of the fingers.

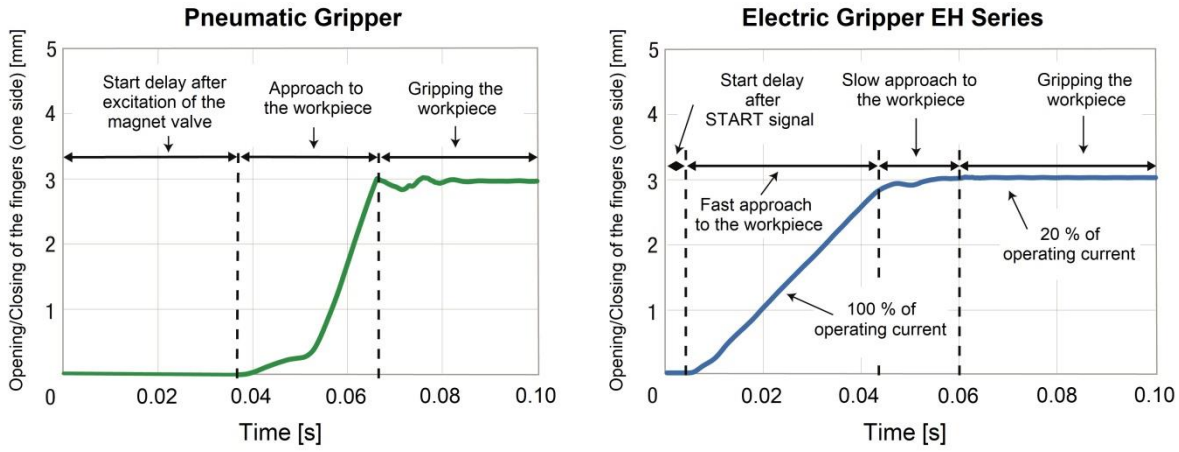

Fig. 5: Faster cycle time of the EH Series (right) compared to a pneumatic gripper (left).

Since the EH Series allows gripping force, speed and position to be controlled separately, operation with a combination of these parameters is easy to implement. In positioning mode, for example, the fingers can travel to a defined position at a higher speed, and then approach the workpiece at a slower speed in pressure mode (Fig. 6). In this way, the cycle time can be shortened significantly. In addition, the time between the start signal and the beginning of the movement is shorter with an electric gripper than with a pneumatic gripper.

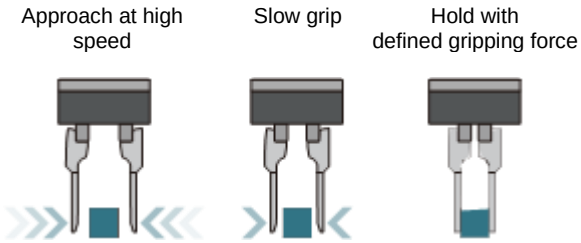

Fig. 6: Faster cycle time through efficient combination of positioning, speed and gripping force.

The slow gripping of the workpiece is particularly advantageous in applications where fragile or soft workpieces have to be gripped and moved.

The AZ motor built into the EH gripper is equipped with an absolute sensor so that no external switches are necessary for the start and end of the movement. For example, the end of the gripping movement is done via the TLC output signal, and checking for the presence of a workpiece is done via the AREA output signal.

Special application workpiece dimensioning
The EH gripper is also able to measure workpieces. To do this, a gripping process is first carried out without a workpiece and the basic position is set with the aid of the CLR and P-PRESET signals. Then the workpiece is gripped and the size is calculated based on the position detected by the driver as follows:

$$L = 2 \bullet x \bullet \Delta L$$

L: Calculated value of the workpiece dimension [mm].
x: Detected position [step]
ΔL: Minimum travel distance (travel distance per pulse) [mm].

Gripping fragile workpieces

The previous explanations on the gripping process of the EH Series referred to the pressure mode of the gripper, i.e. the same gripping force is continuously applied regardless of the workpiece. For particularly fragile workpieces, there is the alternative of using positioning operation.

The stator and rotor of a stepper motor are provided with small teeth. When the winding (coil) of a stator pole is energised, the teeth of the stator and rotor attract each other and face each other at the end. If you apply a torque to the shaft of a stationary motor, the shaft can be rotated slightly. This relationship between torque and the angle of rotation of the shaft is called the angle-torque characteristic (Fig. 7). During the closing movement of the gripper fingers, the torque shown in the phases ① -③ can now be used. The fingers grip the workpiece with a minimally shorter distance than the workpiece dimension, which generates the gripping force. This process is controlled with the help of the operating current value. This method of generating the gripping force is recommended for small workpieces and for a gripping force of less than 6 N, as it is difficult to operate under pressure in this range.

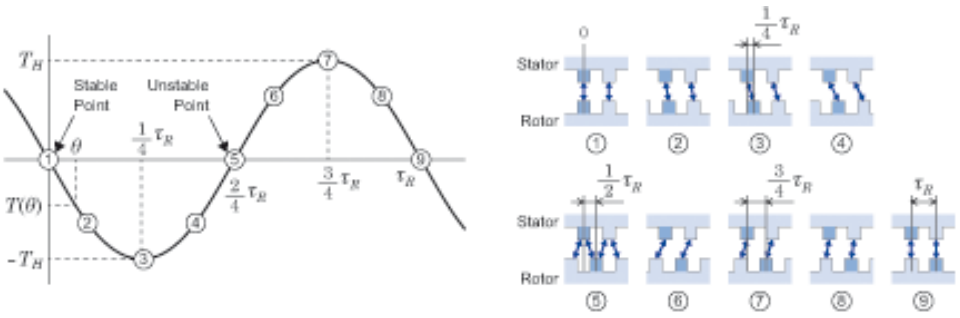

Fig. 7: Angular torque characteristic of a stepper motor.

In summary, depending on the application, the electric gripper of the EH Series is an alternative to pneumatic solutions and offers advantages in terms of precise adjustment of gripping force and speed. Cycle times can be shortened, workpieces can be dimensioned and fragile workpieces can be gripped securely.

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