MultiChoiceGripper

FESTO

Variable gripping based on the human hand

One gripper for the widest variety of shapes

There are already countless different grippers in the automation technology sector today, and each of them has been developed for a special task. If, for example, the shape of a product changes, the corresponding gripper must be replaced on the machine or converted, which requires a great deal of effort. A gripper that is adjusted to different tasks would therefore be ideal.

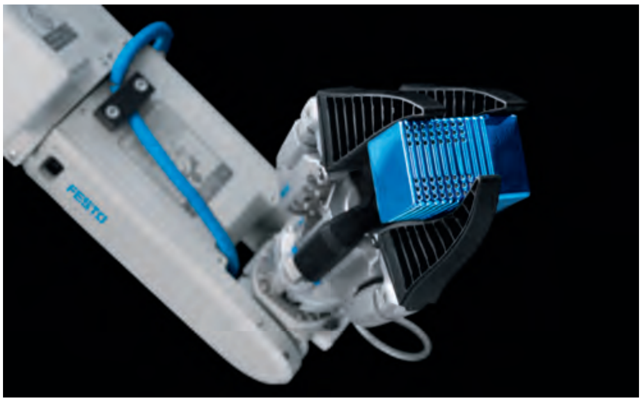
Nature as a model
Nature often provides fresh impetus and new approaches to solutions for industrial applications. That is why Festo brought the Bionic Learning Network to life. In an alliance with reputable universities, institutes and development companies, Festo has already studied a range of different grip principles on several occasions using biology as a model.

The MultiChoiceGripper was the product of close collaboration with the University of Linz as part of a diploma thesis. The pneumatic gripper is inspired by the human hand and is modelled on the thumb, thanks to which humans are also able to grip a wide variety of shapes quickly and easily.

Parallel and centric gripping in one
Just like its natural model, the MultiChoiceGripper unites a unique combination of different grip types. Its fingers can therefore be switched over so that they can either grip in a parallel or centric manner – without requiring any conversion.

Adaptive fingers for form-locking gripping
Due to the adaptive fingers with a Fin Ray® structure, the MultiChoiceGripper is not only variable in terms of the direction of grip, as the fingers themselves can adapt to a wide variety of shapes. The MultiChoiceGripper can therefore handle differently shaped, not to mention very sensitive, objects without additional sensor or control technology. The adaptive fingers were designed in 2009 for the bionic FinGripper and have been continually developed ever since.

Besides the Fin Ray® fingers, two other types of fingers can be attached to the MultiChoiceGripper. Depending on requirements, between two and six finger elements can be fitted to the modular gripper.



Flexible application: different grip types …

… combined with adaptive fingers with a Fin Ray® structure

Universal use: flexible gripping of differently shaped objects

Different tasks, various grips
The MultiChoiceGripper can grip nearly every kind of object – apart from those that are very flat. In order to demonstrate this, in the exhibit it first picks up the top part of a blue ball using the centric grip and puts it to one side. At the same time, there is a dark-blue cuboid in the ball and the gripper lifts this up and then places it next to the ball. At this point a silver-plated cylinder appears; this is also gripped and put to one side. An illuminated blue diamond made of glass is the only thing left.

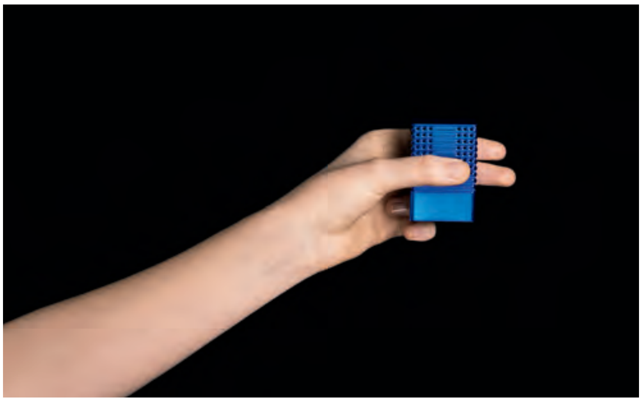
The gripper takes the diamond out of the small holder using its centric-gripping capability and holds it up for show. It then puts the diamond back, covers it with the cylinder and then places the cuboid over the cylinder. The ball is closed once again as the gripper replaces the top part of it.

Integration of functions for force and form fitting
Nature usually focuses on several operating principles with regard to its gripping systems. A combination of force fitting and form fitting is employed most often.

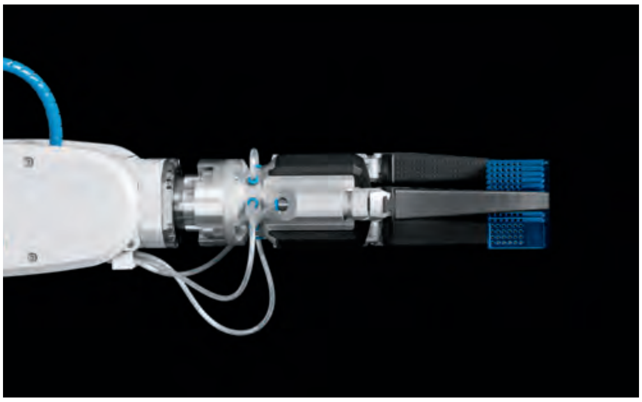
Force-fit gripping involves grasping and holding objects using forces acting on a particular point or area – such as frictional forces, vacuums, negative pressures, or magnetic and electrostatic forces. In the case of the form-fitting principle, the gripper adapts to the object and exerts less force.

When it comes to technology, most grip systems also apply both operating principles. The aim of these systems is to be able to handle objects with different shapes, sizes, surfaces and textures – preferably without converting the gripper.

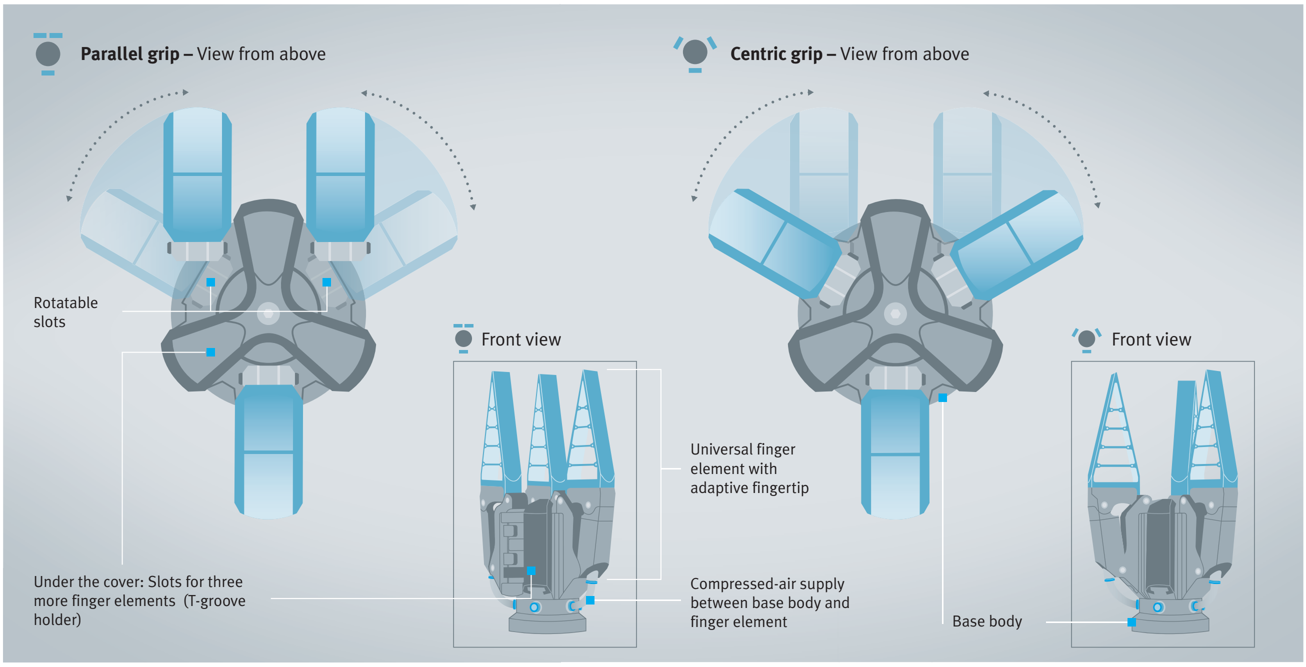
As flexible as the human hand
The MultiChoiceGripper also employs both force and form fitting type of closure by using gripping fingers which are adaptive.
As a result, the MultiChoiceGripper can vary between a parallel or centric grip. This is enabled by two rotatable finger slots on the base body of the gripper, which are arranged either around a central point or opposite the third finger. This is inspired by the opposable human thumb, which is rotated by 130° in relation to the other fingers.



Parallel grip: the principle of the opposable human thumb ...



... transferred to the MultiChoiceGripper



Easy changeover: the mechanical changeover between parallel (left) and centric grip direction (right) removes the need to convert the gripper.

Quick change without conversion

A simple redirection is used as a kinematic technique for changing the direction of grip. A pull-push bar transfers the force to the holders located on the two finger elements, which in turn can be rotated. These holders change the finger position accordingly: either all the fingers are directed towards a central point, or alternatively two of the fingers are arranged next to each other whilst the third finger takes on the function of the opposable thumb to enable a parallel grip.

By means of a mechanical locking system, which is pneumatically operated, the finger elements are fixed in their respective final positions.

Movement with pneumatics

The MultiChoiceGripper is attached to an articulated robot. The robot arm supplies the gripper with three compressed air lines. These provide the compressed air needed to change the grip direction, to move the finger elements and to lock the gripping finger slots.

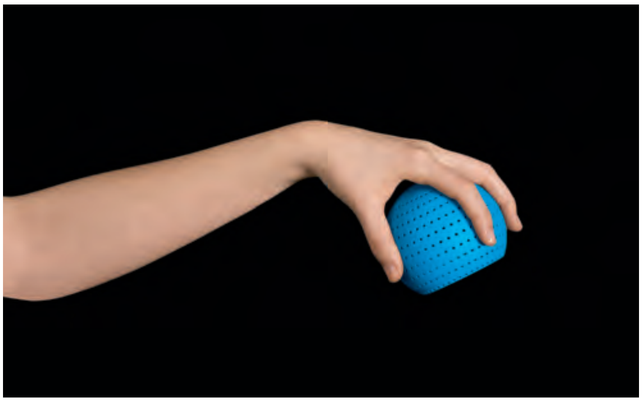
The connection panel between gripper and robot arm acts both as a support system for the compressed air lines and a distributor, which supplies the gripper and fingers with compressed air.

Universal finger elements with integrated drive

The built-in cylinders, which are used for changing the grip direction and locking the finger elements, are located in the gripper's base element. Each element also features an integrated pneumatic microcylinder, which moves the finger joint. Each finger element therefore has its own drive system and can also be operated independently of the gripper's base body using compressed air. This means that the fingers could now also be fitted to other base bodies.

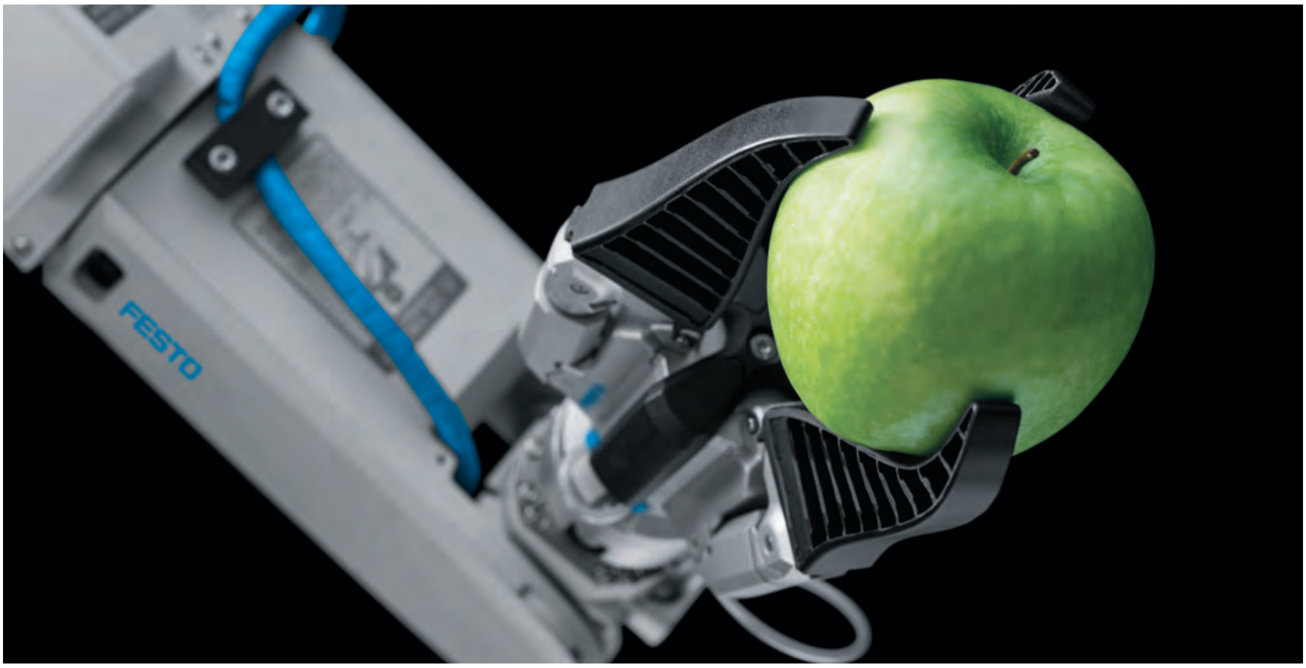
Easy finger changeover with no need for tools

The number of finger elements on the gripper can vary between two and six. Thanks to the holder's T-groove shape, they are easily replaceable. No tools are required to do this – pulling them out or attaching them is sufficient. In this respect, both adaptive, flexible finger elements and a fixed version are available.



Centric grip: shown by the model that is nature ...

... and the technical application with three adaptive gripping fingers



New prospects: the material is compliant with food industry standards and enables a wide range of applications for the adaptive fingers of the future.

Potential future uses
It is conceivable that the MultiChoiceGripper can be applied wherever many different kinds of objects are gripped – for example in auxiliary robotics, for assembly tasks or in production facilities where different products are manufactured. Until now, changeover systems have often had to be used, which were fitted with different grippers.

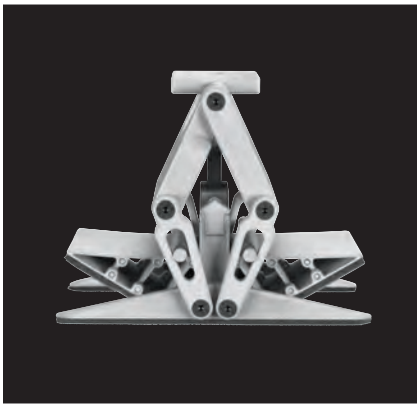
From fish fins to technical applications
Even when sorting fruit and vegetables on a conveyor belt, different gripper systems are still the norm. With the adaptive FinGripper, Festo has already developed a gripping hand that can also grip sensitive objects with different contours in a gentle and form-fitting manner. For this purpose, it makes use of the natural properties of a fish's fin – the so-called Fin Ray Effect®: it does not bend away under the influence of lateral pressure, but instead wraps itself around the point of pressure. Here, the gripping hand with the adaptive gripping fingers is demonstrated among other things by the Bionic Handling Assistant, which was awarded the Deutscher Zukunftspreis (German Future Prize) in 2010.

Continuous development
As part of the continuous development work carried out on the gripping finger, Festo is working on producing it using food-industry-compliant polyurethane, which will enable it to be used in that industry.

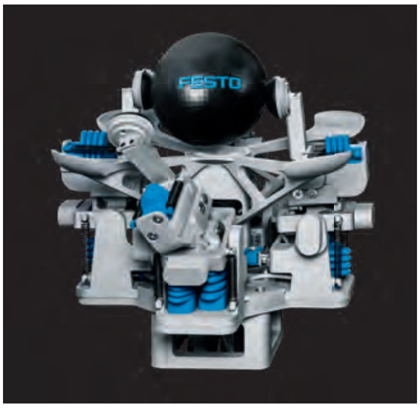
Using a holder and an adapter plate, in future the adaptive fingers will be able to be fitted to different interfaces at customers' premises and to various grippers designed by Festo.

Bionic grippers designed by Festo
The adaptive gripping finger shows how a technical application is developed based on a natural phenomenon. It was used for the first time in 2009 in the Bionic Tripod. The NanoForceGripper (2011) is another bionic gripper developed by Festo and its gripping area was inspired by a gecko's foot. The kinematics of a bird's beak is put into operation in the PowerGripper (2012). In 2013, the developers managed to come up with the LearningGripper research platform, a gripper that is able to learn and can appropriate complex actions by itself.

BionicTripod with FinGripper (2009)



NanoForceGripper (2012)



LearningGripper (2013)

Technical data

- Height: 215 mm
- Diameter: 148 mm
- Material: Aluminium (anodised), partly tool-grade steel
- Weight: min. 660 g; heavier with more finger elements

Possible configuration of the gripping fingers:

- Picker with fingertip made of silicone, opening stroke: 76 mm
- Adaptive finger with Fin Ray Effect® made of food-compliant polyurethane, opening: 92 mm
- Adaptive mechanical gripper with flexible silicone framing, opening: 76 mm

- Robot arm: Six-axis articulated RV-2SDB robot with R56TB touch panel
- Operating pressure: 8 bar
- Interface for gripper: in accordance with DIN ISO 9409-1

Fin Ray Effect® is a brand of Evologics GmbH, Berlin

Project participants

Project initiator:
Dr Wilfried Stoll, managing partner,
Festo Holding GmbH

Project management:
Dr Heinrich Frontzek,
Festo AG & Co. KG

MultiChoiceGripper development:
Dominik Diensthuber, Prof. Axel Thallemer,
University of Linz

Exhibit conception:
Elias Knubben, Jan Averdung, Mart Moerdijk,
Festo AG & Co. KG

→ Film

Festo AG & Co. KG

Ruiter Straße 82
73734 Esslingen
Germany
Phone +49 711 347-0
Telefax +49 711 347-21 55
cc@de.festo.com
www.festo.com/bionic

54835 en 4/2014