Robotino® XT

FESTO

A mobile learning system with the Handling Assistant

Mobile learning flexibly extended

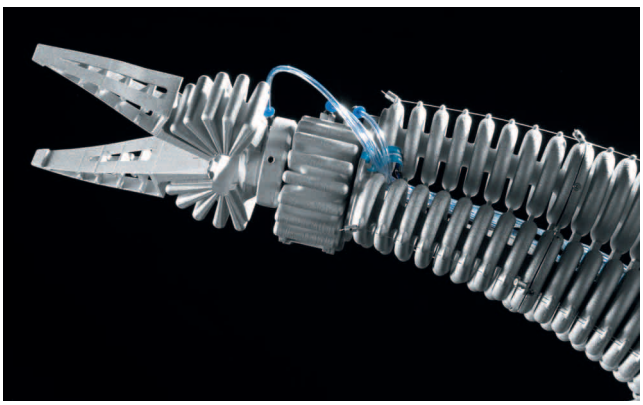
Robotino® XT is a mobile robot application that comprises both a learning system and a research object for future industrial applications. It is based on the Robotino® mobile learning robot developed by Festo Didactic. This system, which has already been established at universities and vocational schools, is being extended with the addition of a compact version of the Bionic Handling Assistant. Robotino® XT can thus not only manoeuvre in cramped spaces: with twelve degrees of freedom in all, this robot can move flexibly and can extend its adaptive gripper with high precision.

Safe human-machine cooperation opens up new perspectives
The flexibility of the gripper arm allows direct human-machine contact. Together with the mobility of Robotino® this opens up new forms of interaction between the human operator and technology, with high potential for extending the scope of human activity in many areas of life.

Excellent yielding behaviour
Together with Fraunhofer IPA, Festo was awarded the German Future Prize in December 2010 for the yielding behaviour of the Bionic Handling Assistant and the resulting risk-free human-machine contact.

The yielding nature of the system is defined by its design, by the material chosen – polyamide rather than metal – and by its control and regulation technology. Its inherently flexible structure is stiffened to a specific degree by the pneumatic control system, so that a predefined spatial movement can be performed. In the event of a collision with the human operator, the system immediately yields, but with no modification to its desired overall dynamic behaviour. The assistant does not constitute a hazard even if the electronics or the control system should fail, since its structurally inherent yielding capability then comes to the fore.

Mobile robotics for learning and logistical tasks



New perspectives with a yielding assistance system

The Robotino® learning system extended by the Bionic Handling Assistant

Up to ten kilometres per hour in any direction
Whether forwards, backwards or sideways – fitted with an omni-drive propulsion unit, Robotino® can move in any direction and can even turn on the spot. Three sturdy industrial DC motors with optical shaft encoders and gears allow speeds up to 10 km/h. The three drive modules of Robotino® are integrated into a stable, laser-welded stainless steel chassis, which is protected against collision by a rubber flap with an integrated power sensor. In the interior are nine infrared distance sensors. An analogue inductive sensor and two optical sensors are also provided. With these, Robotino® can for example recognise and follow predefined paths that are colour-coded or marked by an aluminium strip.

Wireless real-time communication
The core of the PC 104 unit is the Linux real-time operating system provided on a CompactFlash card. Via a serial interface, the operating system communicates with the new EA09 control board to evaluate the sensor data and address the drive units of Robotino®. It can directly communicate with a Linux program in PC 104, and with Robotino® View or another external PC application via W-LAN.

A proven learning system
Thanks to its modular nature, Robotino® has proven is worth as a learning system of Festo Didactic. All its technical components are not only immediately comprehensible; their integrated system behaviour can also be learned. The student integrates and applies a great deal of technology, for example electric drive engineering and kinematics, sensor and control technology, image processing and programming techniques. Technical fundamentals can thus be conveyed in an intriguing, vivid manner. As a mobile robot, Robotino® has a highly motivating effect on young people.

The suitability of Robotino® for logistical tasks is demonstrated by its use in the Festo Logistics Competition. Festo Didactic created this discipline for the 2010 RoboCup university challenge. In a simulated factory, three Robotinos® transport workpieces from a warehouse through the production process to the goods delivery bay; the autonomous robots are required to interact in this process. This competition gives students and researchers the opportunity to learn and to further develop complex and interesting challenges in the field of robotics.

Existing system extended with a biomechatronic gripper arm
Robotino® XT is the extension of this proven system with the addition of a robotic arm based on the bionic model of the elephant's trunk. The mobile robot uses this arm to grasp and move objects.

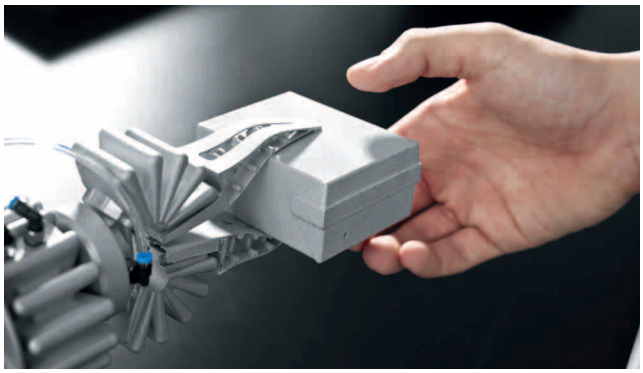
Inspiring technology: Robotino® XT as a learning system for children and adolescents

Child's play: easy operation

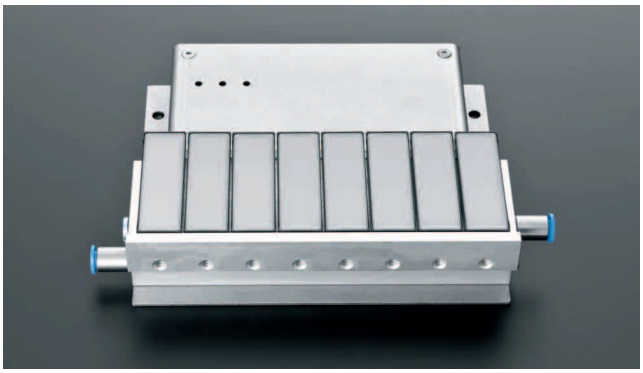
Freedom of movement and form-fitting grip
The nine bellows elements can be specifically charged and discharged by means of compressed air, so that the structure can be displaced and bent in any desired direction. The gripper arm is precisely aligned by a pneumatic 90° rotary actuator. The gripper fingers are also designed on the basis of a biological model. Adaptive gripping of various shapes and contours and of delicate objects is made possible by the structure incorporating the Fin Ray Effect®. Proportionally charging the individual chambers with compressed air gives rise to a powerful movement with adjustable stiffness. Cable potentiometers register the deformation of the light but sturdy structure, and the control system processes the signals accordingly.

A joystick is the interface to the human operator
The operator uses a joystick to control Robotino® and steer the movements of its gripper arm. The control board detects the input signals and conveys the appropriate desired values to the valve terminal via a CAN bus.

Mobile self-sufficiency
The latest piezo proportional valve terminal, which includes its own integrated pressure regulators, precisely meters the pressurised air in the chambers of the gripper arm. The air is compressed by two small membrane pumps, which attain a pressure of 2.5 to 2.7 bar in an integrated pressure accumulator. Two 24-volt batteries supply the valve terminal, pumps, open-loop control and drive units. The operating time available following a complete charging cycle amounts to about two to three hours.



Soft and adaptive gripping: the two-finger version of the DHDG gripper



Precise onboard pressure control: piezo valve technology from Festo

Weight reduction for enhanced performance:
the gripper arm's lightweight structure

Lightweight, low-pressure pneumatics reduces energy consumption

The entire trunk kinematics system, including the adaptive gripper, is designed as a lightweight arm. Every gram of weight that is saved enhances the performance of the overall system. Like the Fluidic Muscle and the bellows cylinder from Festo, the trunk kinematics system is hermetically closed and is thus not susceptible to leakage.

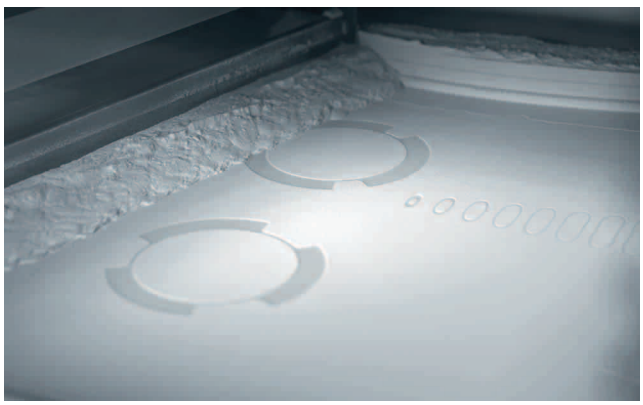
Robotino® XT is operated by means of a low-pressure pneumatic system, comprising two membrane pumps over a pressure range from 0.3 to 2.5 bar. Compared with standard pneumatics, this configuration has the advantage that less energy is required for pressure generation.

Lightweight construction with generative manufacturing technologies

This type of lightweight construction is made possible by the use of modern generative manufacturing technologies. Additive Manufacturing allows the production of individual moving system components from polyamide, which is applied in the production process to a construction platform in thin layers. Each new layer is fused with the underlying layer by a laser and is only cured at the positions specified by the control program. This makes customised 3D printing of complex products possible.

A cost-effective manufacturing process

Generative manufacturing dispenses with tooling costs, and the costs for supplementary materials and equipment are likewise reduced. There are no delays due to the preparation of tools, and the resulting reduction in development time helps increase overall profitability. Rapid response times make for the effective operation of previously time-critical projects.



Efficient "3D printing": additive manufacturing from Festo

Technical data

Robotiono®
- Diameter: 370 mm
- Height, including housing: 260 mm
- Total weight: approx. 11 kg
- Rubber flap with integrated collision protection sensor
- 9 analogue infrared distance sensors
- 1 analogue inductive sensor
- 2 digital optical sensors

Manipulator:
- Height: 330 mm
- Total weight: 1060 g
- Max. payload: 600 g
- 8 degrees of freedom
- Measuring system: 6 cable potentiometers, 1 foil potentiometer

Project partners:

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