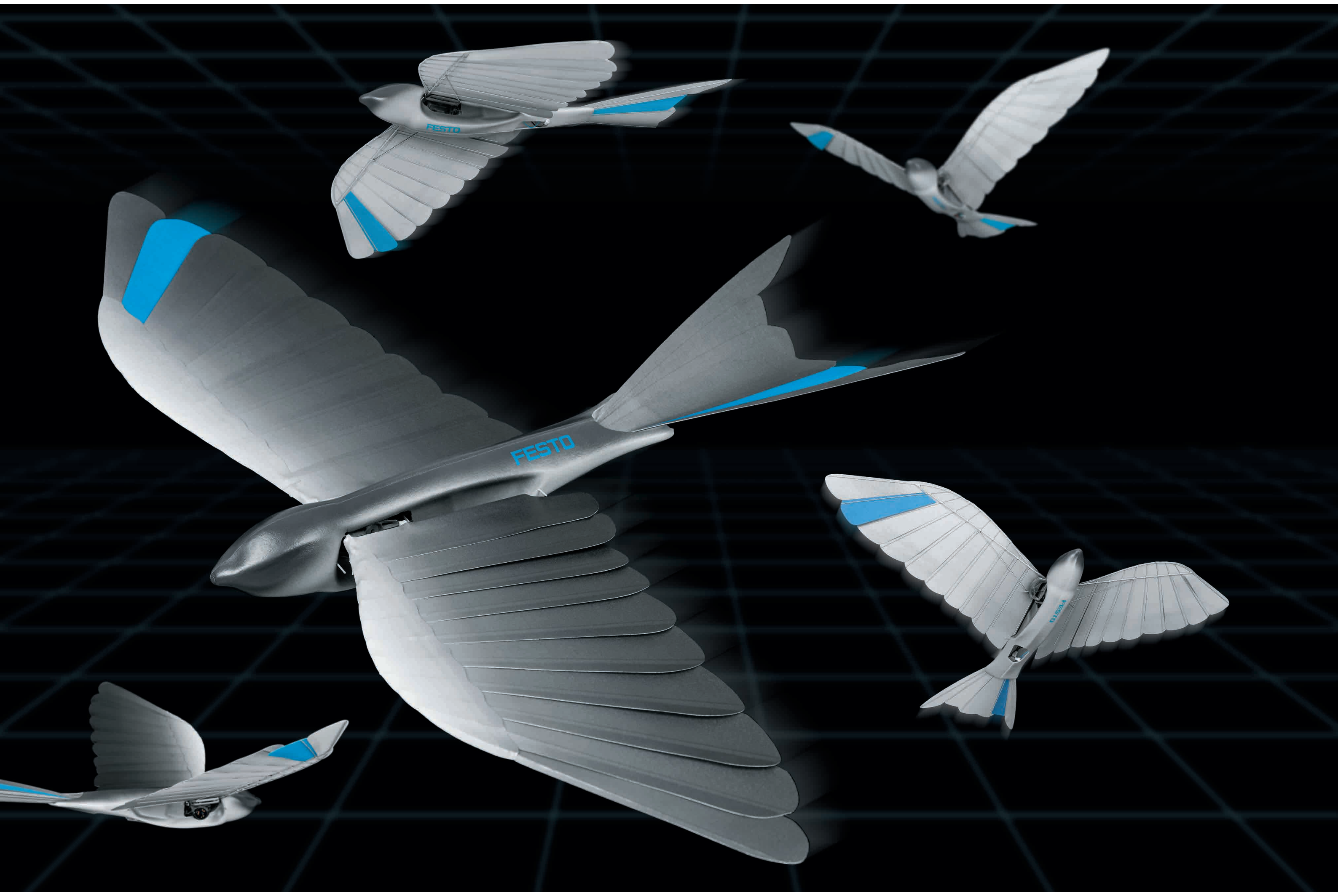
BionicSwift

Safe aerial acrobatics as a swarm



BionicSwift

Agile wing beat based on a natural role model

01: Coordinated flying: flying in formation in a confined airspace

02: Artificial plumage: shingle-like arrangement of the individual lamellae

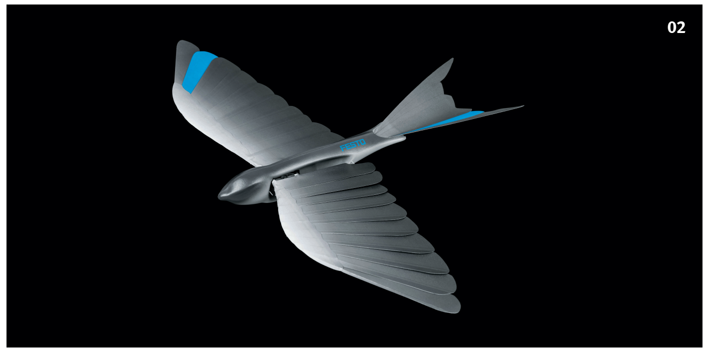
03: Quiet wing beat: lamellae made of light foam

04: Agile flying object: agile manoeuvres such as loops and tight turns

05: Intelligent navigation: master computer, radio module and flying objects interact with each other

06: Aerodynamic kinematics: torsional capacity of the wings


01


02


03


04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06

The flight of birds has always fascinated humankind. In Festo's Bionic Learning Network, flying according to the natural world also has a long tradition. With the construction of the BionicSwifts, Festo is consistently continuing the further development of its bionic flying objects.

Ultralight flying objects

When designing the artificial birds, the focus was on the use of lightweight structures, just like their biological role model. Because the same applies in engineering as it does in nature: the less weight there is to move, the lower the use of materials and energy consumption. And so, with a body length of 44.5 centimetres and a wingspan of 68 centimetres, each of the bionic birds weighs just 42 grams.

The BionicSwifts are therefore very agile, nimble and can even fly loops and tight turns. By interacting with a radio-based indoor navigation system with ultra wideband technology (UWB), the robotic birds can move in a coordinated and autonomous manner within a defined airspace.

Aerodynamic plumage for efficient flight

To execute these flight manoeuvres as true to life as possible, the wings are modelled on the plumage of real birds. The individual lamellae are made of an ultralight, flexible but very robust foam and lie on top of each other like shingles. Connected to a carbon quill, they are attached to the actual hand and arm wings as in the natural model.

During the wing upstroke, the individual lamellae fan out so that air can flow through the wing. This means that the birds need less force to pull the wing up. During the downstroke, the lamellae close up so that the birds can generate more power to fly.

Due to this close-to-nature replica of the wings, the BionicSwifts have a better flight profile than previous wing-beating drives.

Functional integration in the tightest of spaces

The artificial birds owe their agility not only to their lightweight construction and aerodynamic kinematics, but also to the systematic approach to functional integration.

The bird's body contains the compact construction for the wing-flapping mechanism, the communication technology, the control components for wing flapping and the elevator, the tail. A brushless motor, two servomotors, the battery, the gearbox and various circuit boards are installed in a very small space.

The intelligent interaction of motors and mechanics allows, for example, the frequency of the wing beat and the elevator's angle of attack to be precisely adjusted for the various manoeuvres.

Coordination of flight manoeuvres by GPS

Radio-based indoor GPS with ultra wideband technology (UWB) enables the coordinated and safe flying of the BionicSwifts. For this purpose, several radio modules are installed in one room. These anchors then locate each other and define the controlled airspace.

Each robotic bird is also equipped with a radio marker. This sends signals to the anchors, which can then locate the exact position of the bird and send the collected data to a central master computer which acts as a navigation system.

This can be used for route planning, so that preprogrammed routes give the birds their flight path. If the birds deviate from their flight path due to sudden changes in environmental influences such as wind or thermals, they immediately correct their flight path themselves and intervene autonomously in this situation – without a human pilot. Radio communication enables exact position detection even if visual contact is partially hindered by obstacles. The use of ultra wideband as radio technology guarantees safe and trouble-free operation.

New impetus for intralogistics

The intelligent networking of flight objects and GPS routing makes for a 3D navigation system that could be used in the networked factory of the future. The precise localisation of the flow of materials and goods could, for example, improve process sequences and foresee bottlenecks.

Moreover, autonomous flying robots could be used to transport materials, for instance, and thus optimise the use of space within a factory with their flight corridors.

Technical data

Flying objects:
- Wingspan: .... 68 cm
- Total length: .... 44.5 cm
- Weight: .... 42 g
- Drives: ....2 servomotors with an actuating force of 700 g, each weighing 4.8 g
  1 brushless motor, 4,200 rpm/V
- Battery: ....1 LipoHV battery 4.35 V, 6 g weight
- Flight time: .... approx. 7 min.
- Radio receiver: .... 4 × 2 cm, 1 g weight
- 3 radio boards: .... 1× UWB (ultra wideband)
  ....1× localisation
  ....1× controller

Material of flying objects:
- Feathers: .... light foam, 0.4 mm thickness
- Body: ....Depron, 1.5 mm thickness
- Gearbox: ....3D-printed nylon/polyamide
- Wing structure: .... pultruded CFRP round profile,
  .... struts: 1.3 mm diameter,
  .... keel: 0.7 mm diameter

Indoor GPS:
- 8 anchors with UWB technology
- Update rate anchor: ....30 Hz
- Frequency band: .... 5–6 GHz
- 1 central master computer
- Path planning: ....Cinema 4D
- Software for position detection: ....Localino®
- Transmission of the telemetry data: ....by radio over 433 MHz
- Position recognition: ....gyro position sensor

Project participants

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Localisation software with UWB technology
Heuel & Löher GmbH & Co. KG, Lennestadt

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