Advanced Model of World's Smallest Flying Microrobot from Epson

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Seiko Epson Corporation ("Epson") announced that it has successfully developed a lighter and more advanced successor to the uFR, the world's smallest and lightest micro-flying robot. Turning once again to its micromechatronics technology, Epson has redefined the state of the art with its uFR-II micro-flying robot - the world's new lightest and most advanced microrobot, which also features Bluetooth wireless control and independent flight[*2]. The uFR-II will be on display at the Emerging Technology Fair, part of the Future Creation Fair that runs from August 27 to 30 at the Tokyo International Forum.

Epson has long been engaged in the research and development of microrobots and in the development of applications for their enabling technologies. The uFR-II is only the latest chapter in an Epson success story that began with Monsieur, a microrobot that was listed in the

Guinness Book of Records as the world's smallest microrobot and was put on sale in 1993. Having made micromechatronics one of its core technologies, the company has since created and marketed several more microrobots in the EMRoS series[*3]. April 2003 saw the introduction of the Monsieur II-P, a prototype microrobot that operates on the world's thinnest microactuator (an ultra-thin, ultrasonic motor)[*4] and is remote-controllable via a power-saving Bluetooth module. The following November, Epson unveiled the prototype micro-flying robot uFR, which featured two ultra-thin, ultrasonic motors driving two contra-rotating propellers for levitation, plus the world's first[*5] linear actuator stabilizing mechanism for attitude control during flight.

However, the uFR prototype microrobot's flying range was limited by the length of the power cord attaching it to an external battery, and although it was radio-controlled, it had to be kept within sight of the operator while flying. Consequently, Epson decided that the next step was to extend the flying range by developing fully wireless operation paired with independent flight capability. The main issue to be tackled with regard to wireless flight was the need to combine lighter weight with greater dynamic lift. Epson made the robot lighter by developing a new gyro-sensor that is a mere one-fifth the weight of its predecessor, making it the world's smallest and lightest[*6] gyro-sensor. Also helping to shed weight is the high-density mounting technology used to package the microrobot's two microcontrollers including the Epson-original S1C33-family 32-bit RISC. Dynamic lift was boosted 30% by introducing more powerful ultra-thin ultrasonic motors and newly designed, optimally shaped main rotors. As for the challenge of independent flight, Epson brought its many years of micromechatronics experience to bear in realizing the development of a linear actuator with faster response time and a high-precision attitude control mechanism, and a flight path control and independent flight system (primarily for hovering).

To top it off, Epson added an image sensor unit that can capture and transmit aerial images via a Bluetooth wireless connection to a monitor on land, and they also devised two LED lamps that can be controlled as a means of signaling. Epson was assisted by Chiba University's Nonami (Control and Robotics) Laboratory in developing the control system for independent flight. The company also received advice on the rotor design from the Kawachi (Aeronautics and Astronautics) Laboratory at the University of Tokyo.

The key concept behind Epson's R&D efforts in micro-flying robots has been to expand the horizons of microrobot activities from two-dimensional space to three-dimensional space. Now, with the successful implementation of Bluetooth communications and independent flight in the uFR-II, Epson has literally added a new dimension to microrobotics while greatly expanding the potential range of microrobot applications by incorporating image capture and transmission functions. At the Emerging Technology Fair, the uFR-II micro-flying robot's features are expected to be showcased in artistic aerial performances. Epson hopes to gain feedback from visitors at this exhibit that may be useful as the company strives toward further progress in developing original micromechatronics technologies and applications.

*1: Weight excluding battery, according to Epson's research
*2: Independent flight is the ability to follow a computer-programmed flight path
*3: "EMRoS" stands for "Epson MicroRobot System." This series included four main models: Monsieur (listed in the Guinness book of Records as the world's smallest—only 1cm3 in volume, 1993), followed by Nino (a 0.5-cm3 model introduced in 1994), Ricordo (1cm3, equipped with a recording and playback function, 1995), and Rubie (1 cm3, equipped with a capricious wandering function, 1995.) All of these models are independent traveling robots that chase a light source. Sales of the EMRoS series have been discontinued.

*4, 5, 6: According to Epson's research

Overview of the uFR-II micro-flying robot

Features

Wireless features

- Epson's own gyro-sensor (world's smallest and lightest)
- Two Epson original S1C33 Family of 32-bit RISC microprocessors, on board with high-density mounting
- Able to use commercially available battery (polymer-lithium battery) thanks to lighter weight and more efficient drive circuitry
- Actuator has the world's highest power-weight ratio (according to company research), providing 30% more lift than the uFR

Independent flight features

- World's first linear actuator-equipped balance control system for higher precision and faster response
- Epson's proprietary flight path control and independent flight system (primarily for hovering)

General specifications

1. Power: 4.2 V
2. Power consumption: 3.5 W
3. Dimensions
Diameter: About 136 mm
Height: About 85 mm
(Note) The uFR-II is slightly larger than the uFR, which remains the world's smallest micro-flying robot.

4. Maximum lift: About 17 g/f
5. Weight: 8.6 g (total weight without battery), with battery: 12.3 g
3.7 g (battery)
2.9 g (rotary actuator unit)
0.6 g (linear actuator unit)
3.1 g (control circuitry)
2.0 g (frame)
6. Flight time: About 3 minutes

More about uFR:

Seiko Epson Corporation ("Epson") has developed the uFR ("Micro Flying Robot"), the world's smallest flying prototype microrobot. Epson developed the uFR to demonstrate the micromechatronics technology that it has cultivated in-house over the years and to explore the possibilities for microrobots and the development of component technology applications.

Based on its micromechatronics technology, which is one of the company's core technologies, Epson has developed and marketed a family of microrobots known as the EMRoS series, beginning with Monsieur, which was put on sale in 1993 and is listed in the Guinness Book of Records as the world's smallest microrobot. In April of this year Epson developed Monsieur II-P, a prototype microrobot that operates on an ultra-thin, ultrasonic motor and a power-saving Bluetooth module that allows multiple units to be remote-controlled simultaneously. Using these robots, Epson also realized the world's smallest full-blown robot ballet theater. In this way, Epson has played a pioneering role in research and development relating to microrobots and component technology applications.

Source: Epson