

A Flying Robot that can Walk

The issue of how to use one robot in multiple terrains is an ongoing question in robotics research. In a paper published in *Bioinspiration and Biomimetics* today a team from LIS, EPFL and NCCR Robotics propose a new kind of flying robot that can also walk. Called the DALER (Deployable Air-Land Exploration Robot), the robot uses adaptive morphology inspired by the common vampire bat, *Desmodus rotundus*, meaning that the wings have been actuated using a foldable skeleton mechanism covered with a soft fabric such that they can be used both as wings and as legs (whegs).



The DALER uses wings inspired by bats (Photo: © LIS/EPFL and Alain Herzog 2014).

As the DALER is being designed to be used in search and rescue operations, the duality of modes of locomotion will be used principally to fly long distances to survey large spaces in a short timespan, and then to walk into dangerous or inaccessible areas.



Rotating wingerons allow the robot to walk (Photo: © LIS/EPFL and Alain Herzog 2014).

One of the main issues in using a flying robot to navigate in small areas when walking is the surface areas of the wings. On a flying wing shaped robot, in order to maintain flight the wings must be wide, meaning that they cannot fit into smaller spaces. By observing *D. rotundus* the team has produced an elegant solution where a foldable actuator is used to allow the wings to fold into a smaller space and to rotate around a hinge attaching the whegs to the body, allowing walking. *D. rotundus* doesn't look very pretty when it walks, but it has certainly perfected the art of using all four limbs for two purposes.

In order to design the robot, the team had to first designate the primary mode of locomotion – in this case flight, as the DALER will cover the longest distances this way. With this in mind, a method of using the wings also for walking was devised in a way that does not give extra weight. The resulting wing is equipped with wingerons on the tip which rotate to allow the robot to “walk” when it is on the ground.

An issue in creating a fixed wing drone capable of walking on the ground is with the morphology due to the different centre of mass requirements for the two modes of locomotion. For this reason the DALER is equipped with foldable wings, so much like the bat that inspired it, the DALER can walk on its haunches.

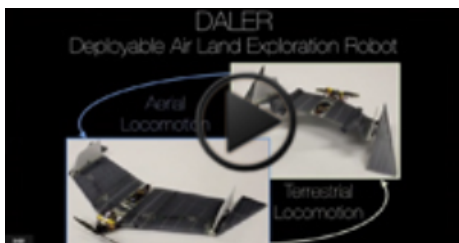
The team have found the optimal distance between the centre of mass of the robot and the axis of rotation of the wingerons, in order to minimize the cost of transport (i.e. energy efficiency) and allow the DALER to reach 20m/s in the air and 6cm/s on the floor, with a maximum step distance of 6cm.

It is hoped that a future application of the DALER might be to find victims in dangerous areas after a natural disaster. The DALER can be remotely deployed to fly to an affected area, and then can walk through a disaster zone (e.g. a damaged building) to locate victims, meaning that human rescue teams can concentrate their efforts where they are needed, rather than using time to search for victims in a dangerous environment. Future development of the DALER will include the possibility to hover and to take off



The DALER extends its wings to fly (Photo: © LIS/EPFL and Alain Herzog 2014).

autonomously from the ground in order to allow the robot to return to the air and come back to base after the mission.



For enquiries please contact Linda Seward: linda.seward@epfl.ch +41 (0) 21 693 73 16 / +41 (0) 44 632 36 38

A full transcript of the paper is available online:

L. Daler, S. Mintchev, C. Stefanini and D. Floreano, "A bioinspired multi-modal flying and walking robot," *Bioinspiration & Biominimetrics*, 10, 2015, doi:10.1088/1748-3190/10/1/016005

NCCR Robotics

The Swiss National Center of Competence in Robotics (NCCR Robotics) is a federally funded programme bringing together robotics laboratories from EPFL, ETH Zurich, University of Zurich and University of Lugano to work on wearable, rescue and educational robots.

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CONTACT DETAILS

NCCR Robotics Director

Prof. Dario Floreano

Publisher

NCCR Robotics
Management Team

Editor

Linda Seward

Web Editing

Mayra Lirot / Pascal Briod

Design

Alternative
Communication SA

NCCR Robotics

Office ELG 231, Station 11

EPFL CH-1015 Lausanne

Switzerland

+41 21 693 69 39

nccr-robotics@epfl.ch / nccr-robotics.ch

