Press release
November 29th, 2017

Inria and CNRS join the ScanPyramids multidisciplinary team and unveil a concept for a minimally invasive exploration robot.

Inria and CNRS are teaming up with the Faculty of Engineering of Cairo University and the HIP Institute (Heritage, Preservation, Innovation) with the support of the Robeauté company and La Fondation Dassault Systèmes to design an innovative robot that could explore heritage buildings while leaving as few traces as possible. Scientists call this approach « *minimally invasive robotic exploration* ».

The overall idea is to use a hole with a diameter of less than 3.5 cm (about 1.5 inches) to insert a tiny robot that would allow scientists to remotely explore inaccessible places. « *There is currently no concrete plan to send this robot in any particular monument* », says Jean-Baptiste Mouret, an Inria researcher in team Larsen specialized in artificial intelligence and robotics, who is the leader of the project, « *but it is the right time to imagine, develop and validate the technologies that are needed to explore heritage buildings ».* The goal of the ScanPyramids mission is to better understand how the pyramids of the Old Kingdom were built, but also to encourage innovations in various fields (muography, virtual reality, simulation, …) that could be useful for the pyramids as well as for other monuments. The ScanPyramids team has discovered several previously unknown voids in the pyramid of Cheops, one of them with a size similar to the one of the Grand Gallery, called « ScanPyramids' Big Void » [Morishima and al., Nature, 2017]. "*The challenges raised by the pyramids fertilize science and technology more than ever before. New emerging robotics are at the service of archaeology for this second stage of the mission*, " says Bertrand Duplat, inventor-engineer, and HIP scientific advisor who initiated the robotic project for the association, and co-inventor, with Jean-Baptiste Mouret, of the initial concept.

The team envisions exploration to take place in two stages. At first, a tubular robot fitted with an omnidirectional camera would be inserted to take high-resolution pictures of the inaccessible place. In a second stage, the team would use the same hole to send an exploration robot operated remotely to travel through corridors and help mapping the interior.

For this second step, the team is currently designing a miniature blimp (or miniature airship) that would be folded during the insertion, then remotely inflated once in the inaccessible place. When the exploration is over, the airship would come back to its base, be deflated, then extracted from the insertion hole. The main challenge is to successfully introduce in a hole of only 3.5 cm the envelope of the blimp, the gondola, and all the mechanisms to deploy the robot. Once inflated, the blimp will have a diameter of 80 cm and a mass of about 60 g.

This flying robot will benefit from Inria's experience in robotics and from the bio-inspired sensors and principles designed for micro aerial vehicles at the Institut des Sciences du Mouvement (CNRS/Aix Marseille University) at the instigation of Franck Ruffier, a CNRS researcher. The sensors and the embedded artificial intelligence would allow the pilot to easily avoid obstacles and land precisely on the docking station before the extraction.

Flying brings several advantages over wheeled or legged locomotion: (1) aerial robots have no problem with stairs, ramps, rocks, or objects on the ground, (2) they can offer many points of view and, (3) they move faster than conventional miniature robots. The team is currently focusing on a blimp, rather than on more conventional multi-rotor "drones", because blimps are safer for monuments: they can touch obstacles without crashing and without risking damage to the monument. They are, moreover, intrinsically stable, which is important for taking pictures in low-light conditions, and they are more energy-efficient than multi-rotors. The blimp would carry a set of lights, a camera, numerous sensors for assisted navigation, and four miniature motors to move in all directions.

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About

About Inria

Inria, the national research institute dedicated to computational sciences, promotes "scientific excellence for technology transfer and society". Inria employs 2,400 people from some of the world's leading universities to rise to the challenges of digital sciences.

Its open and agile model allows Inria to explore original paths with his industrial and academic partners. Inria thus effectively responds to the multidisciplinary and application challenges of the digital transition.

Inria has helped to shape the digital world we know today and is at the root of many value-creating and job-creating innovations. In 2017, Inria celebrates its 50th anniversary and is committed to rise to the challenges of 21st century digital science.

About the Loria (Inria/CNRS/Université de Lorraine)

The Loria "Lorraine Research Laboratory in Computer Science and its Applications" is a research unit (UMR 7503), common to CNRS, Université de Lorraine and Inria. Since its creation in 1997, its mission is fundamental and applied research in computer sciences. Its scientific work is conducted in 28 teams including 15 common teams with Inria. One of them is team LARSEN, of which Jean-Baptiste Mouret is part of.

The team's generally interested in the use of robots outside of the research labs and manufacturing industries, for example factories of the future, assistance to people or any other field requiring a collaboration between man and robot.

Specialized in artificial intelligence and robotics, **Jean-Baptiste Mouret** joined the LARSEN team in May 2015. He works on robots capable of adapting to damages and unexpected situations (ResiBots project, funded by the European Research Council) but he is more generally interested in all the challenges raised by the use of robots outside of the controlled conditions of laboratories and factories.

About Institut des Sciences du Mouvement (ISM) – CNRS/Aix-Marseille University

L'Institut des Sciences du Mouvement (ISM) is a Joint Research Unit, associating Aix-Marseille University and the CNRS. With nearly 150 members, the ISM is developing a series of interdisciplinary research projects aimed at studying the neurophysiological, mechanical, and sociocultural determinants of movement regulation and expression. In particular, the biorobotics team develops new sensorimotor capabilities based on active perception, where the robot's movement is at the service of visual perception. The team works on the application of these principles and those minimalist micro-sensors to miniature flying vehicles, especially outside controlled conditions.

About the ScanPyramids mission

The ScanPyramids mission (www.scanpyramids.org) is a scientific project designed and coordinated by the Faculty of Engineering of Cairo University and the HIP Institute (www.hip.institute, Heritage, Innovation, and Preservation Institute, Paris). The objective of the mission is both to better understand the pyramids of the Old Kingdom and to encourage interdisciplinary innovation through the intersection of science, art and technology. Although the mission is currently focused on non-invasive techniques, the enthusiasm generated by the recently published results [Morishima et al., Nature, 2017] inspires to lay the groundwork for other potential approaches.

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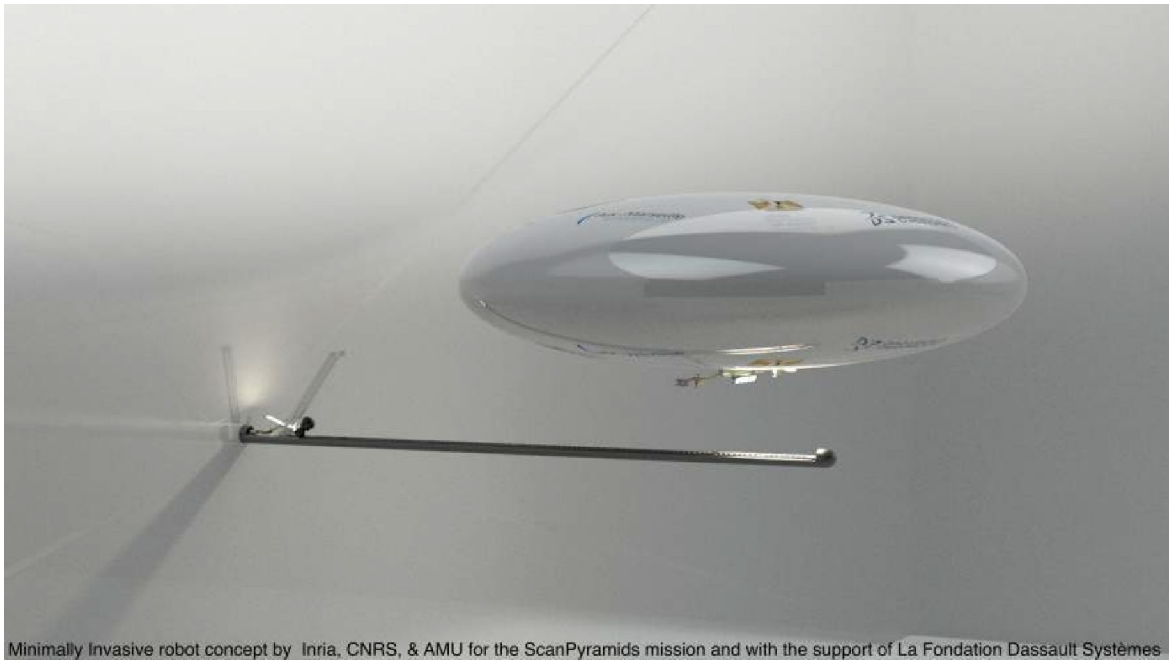

Image 1 : 3 D rendering of the exploration robot and its docking station (artist view).

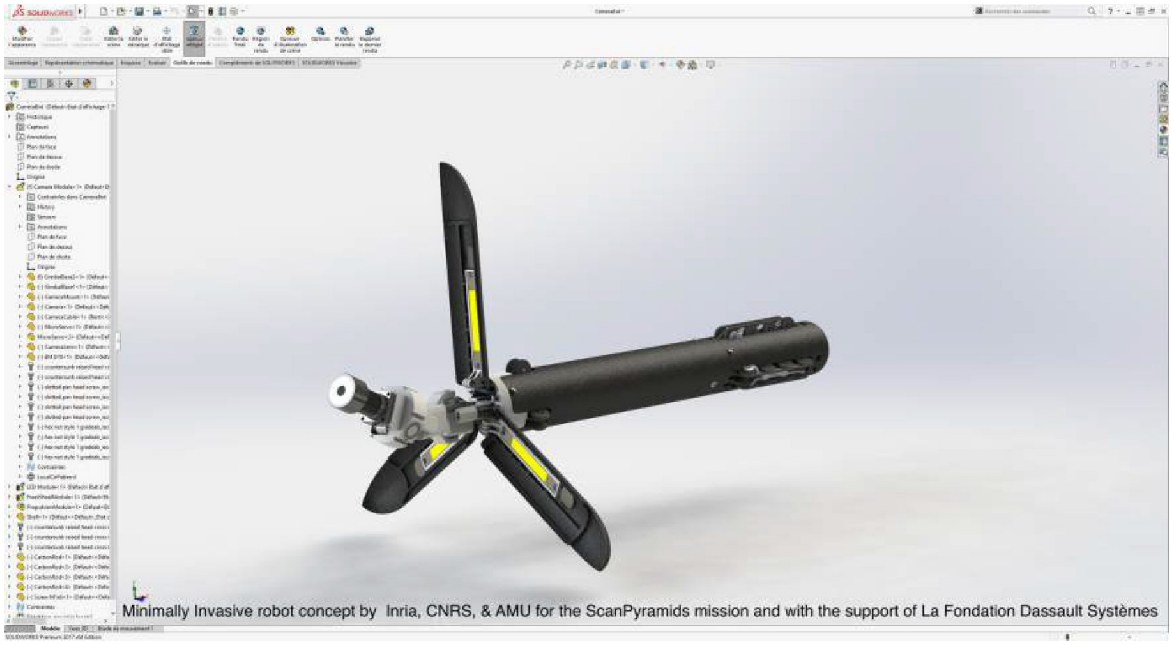

Image 2 : 3D rendering of the imaging robot with the pan-tilt camera (open) (artist view)

Image 3 : 3D rendering of the imaging robot with the pan-tilt camera (open) (artist view)

Image 4 : 3D rendering of the imaging robot with the pan-tilt camera (closed) (artist view)

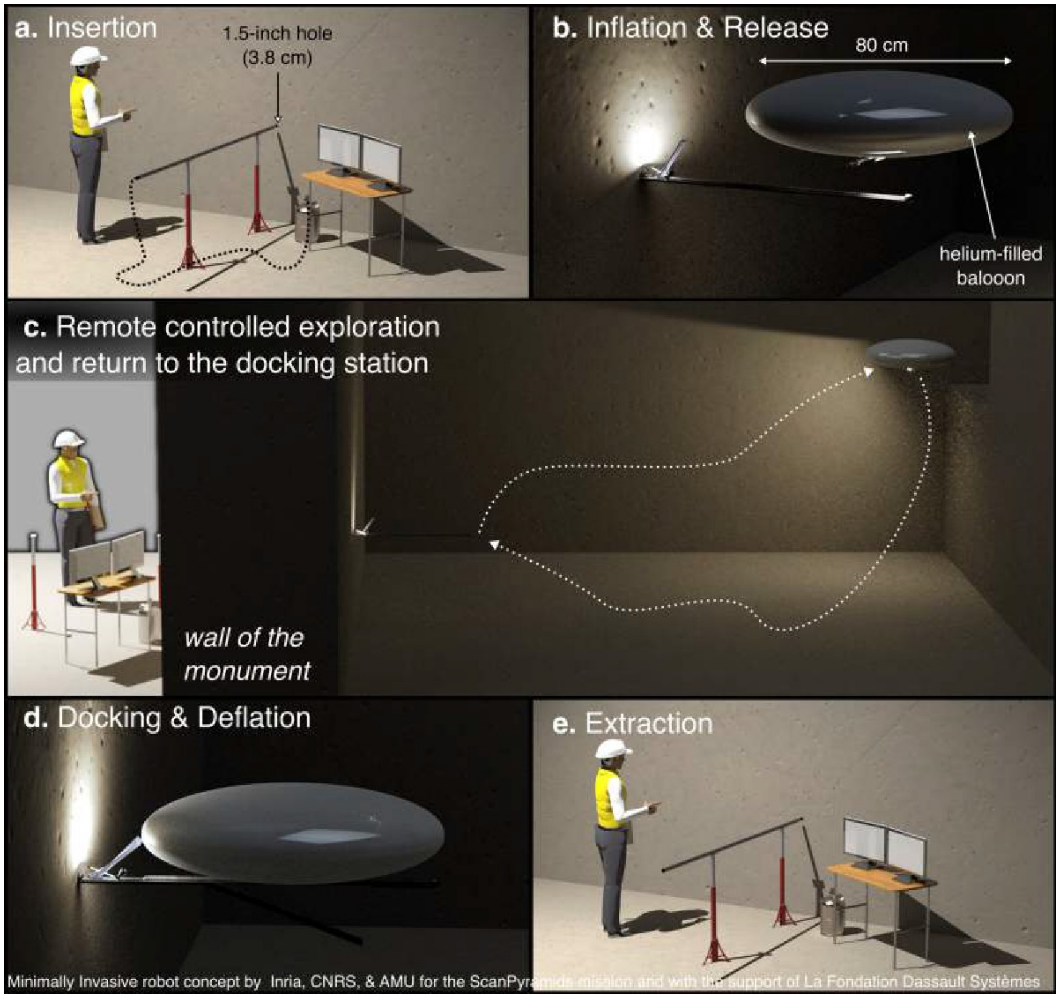

Image 5 : Concept of the deployment of the exploration robot to explore an inaccessible place including return, docking, deflation and extraction phases.