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SpaceBR Show

Drone based Multimode/Multiband Radar to Explore Mars and the Earth: the FlyRadar Project

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FlyRADAR

Consortium

Affliation n°	Partecipant Organization & Country	Role
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3	UCBL, CNRS, UMR 5276 LGL-TPE, France	Beneficiary
4	Hyperion Seven, Claix, F-38640	Beneficiary
5	CSFK Sopron 9400, Hungary	Beneficiary
6	Dipartimento InGEO, Università "G. D'Annunzio" of Chieti-Pescara, Italy	Beneficiary
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8	Exploration Sarlau, Marrakech, Morocco	Collaborator

Abstract

The proposal deals with the production of a dual-mode, low-frequency, radar installed on board of a leight-weight UAV. The radar will operate into two modes: as Synthetic Aperture Radar (SAR) and as ground penetrating radar. Both instruments provide extremely interesting images that are extensively used in Earth and Planetary observations. However, these airborne systems are bulky and can be operated only from manned aircraft both planes and helicopters. On the other hand, the few drones that can sustain such a equipment are large and heavy. In both cases, the operations are expensive and with a complicate logistic. The quantum leap of FlyRadar consists in installing this radar system onboard a small and light electric octocopters, providing low cost utilisation and easy operations. This affordable system will enlarge the user communities generating the possibility for an extensive use of FlyRadar taking advantage of the potentiality of this long-lasting innovation. The use of SAR and penetrating radar is widespread in Earth observation spanning from geological survey to archeological prospecting, from agricultural assessment to artefact detection. However, FlyRadar could be used also in planetary exploration. The NASA mission Mars2020 will test a drone and it will pave the way for the utilisation of UAVs in the in-situ exploration of Mars and Titan. The project is split in two phase. The first half of the project will be devoted in identifying the requirement, in designing instruments and in building them. The second half will be dedicated to the evaluation of FlyRadar with three experiments lasting a month each. The tests will performed in dry desert areas to avoid the negative effect of ground water and humidity on the radar signal. The test executions will be matched by month-long joint sessions for the analysis of the data, assess the scientific value and investigate the technological aspects.

Project

Title: Low-frequency multi-mode (SAR and penetrating) radar onboard light-weight UAV for Earth and Planetary exploration
Acronym: FlyRadar
Call identifier: H2020-EU.1.3.3.
Topic: MSCA-RISE-2020 – Research and Innovation Staff Exchange
Funding scheme: MSCA-RISE – Marie Sklodowska-Curie Research and Innovation Staff Exchange (RISE)
Grant Management number: 101007973
Estimated Project Cost and Requested EU Contribution: € 1 021 200

Duration: 48 months
Start Date: 01 Feb 2021
End Date: 31 Jan 2025

Introduction

The aim of the FlyRadar project is to develop a multimode (GPR and SAR) multi frequency radar installed on board a UAV dimensioned for Martian exploration and tested on Earth. A GPR is an active remote sensing probe that emits electromagnetic waves and receives the waves reflected by discontinuities that can be the surface of the planet or permittivitycontrasts in the interior. Echo analysis provides geometrical and geological information on the surface features to a depth about 100 m that depends on the permittivity of material.

Mars is particularly suitable for exploration with such an instrument. The upper crust of Mars is composed of rocks of various origins (volcanic, sedimentary, impact, etc.) clearly visible at the surface of the planet. Mars also presents two permanent polar caps and a range of shallow subsurface buried ice masses in the middle latitude region. The shallow 3D subsurface geometry of these geological features is generally poorly known, but will be accessible using a GPR-SAR instrument.
The efficiency of GPR has already been demonstrated on Mars (Figure 1). Two orbital radar sounders that work as GPR (MARSIS on Mars Express and SHARAD on MRO) have successfully operated in the last 20 years [1, 2]. These two instruments provided the first images of the subsurface of Mars. The RimFax instrument [3] on board the Perseverance rover is currently in operation to provide high resolution sections of the underground of the Jezero impact crater on Mars.

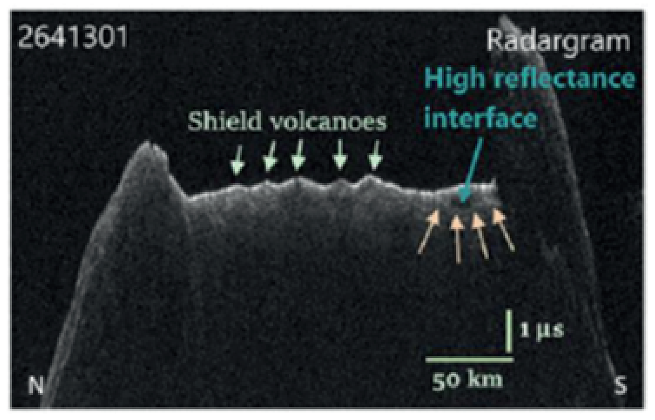


Figure 1: Radargram generated using SHARAD echoes [4] showing layers on the top of Arsia Mons, a Martian shield volcano. These reflectors are interpreted as the interfaces of buried volcanic layers.

The FlyRadar system will operate several tenth of meters aboveground on board a UAV, providing precise and high resolution data, which will be critically needed for example, for future Mars sample return initiatives and human missions.

Conclusion

The aim of the FlyRadar project is to develop, to test and build a radar system able to work in both GPR and SAR mode installed on board a UAV.
This instrument will be a demonstrator of a system that could operate on Mars in assistance with a rover for the exploration of the Martian environment in the vicinity of the rover at high spatial resolution.

The planned tests at analog sites on Earth will help to improve and fine tune the instrument with a workflow to prepare and optimize the system to Martian usage. Because radar technologies have a strong potential for Earth application in arid areas too, the FlyRadar system will also be useful for archeological and geological exploration on Earth.

Methodology

Objectives

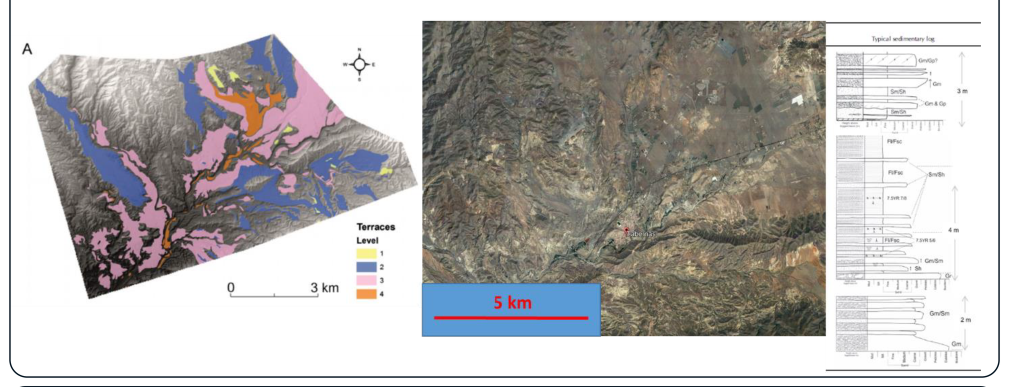
The Fly-Radar project aims to pursue a series of scientific, technical and business oriented objectives (**Obj**), in addition to training and mobility objectives (**T&M**):

Obj-1 Apply the comparative knowledge of the participants	**T&M-1** Development of an initial research and training network
Obj-2 Achieve ideal application of radar facility	**T&M-2** Multidisciplinary and international approach based on the development of a prototype
Obj-3 Validate and adapt a prototype using terrestrial analogue	**T&M-3** Support early career researchers
Obj-4 Identify the economic feasibility and impact of the instrument for both space and non-space markets	**T&M-4** Development in a competitive business market environment

The project is organized around technical, scientific and qualification work packages. The aim of technical WPs is to provide a fully operational system that will be tested on Earth in analog environments. As part of the exploitation of the results, a requirement engineering analysis will be performed in order for end-user to assemble the FlyRadar products and match the scientific objectives.
The qualification of the instrument will ensure that radar, UAV and their integration will comply with the FlyRadar specific requirements for scientific efficiency

Work Packages

WP1
Scientific aims for Mars Surface analyses and Terrestrial analogues



WP2
System Requirements

	Earth	Mars
Vertical Resolution [m]	0.1 to 5	0.1 to 5
Horizontal Resolution [m]	0.1	0.1
Covered surfaces [km²]	1	0.5
Distance between tracks [m]	< 10	< 20

WP3
Design and manufacturing radar

Electronic system ⟷ Antenna front-end ⟷ Antenna

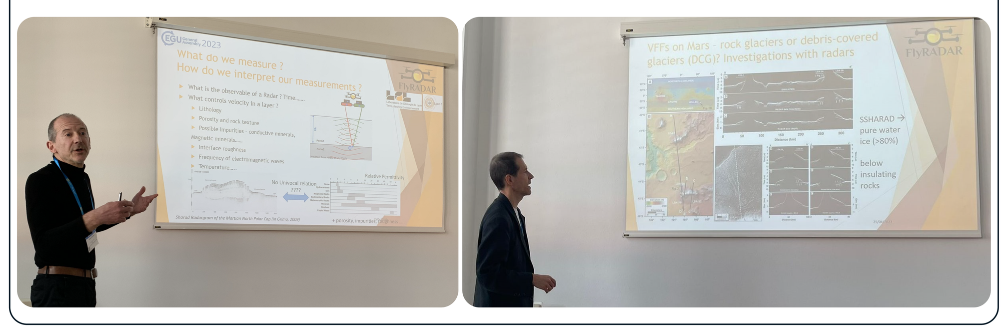
WP4
Design and manufacturing drone

WP5
Model qualification campaign

WP6
Validation and test field campaign

WP7
Transfer of knowledge, training and networking

WP8
Communication, Dissemination and Exploitation



WP9
Project Office

Project Status

100%	WP1	100%	WP2	100%	WP3
100%	WP4	100%	WP5	48 %	WP6
77 %	WP7	72 %	WP8	74 %	WP9

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