

Modern Analytical Methods Applied to Earth and Planetary Sciences for Micro, Nano and Pico Space Devices and Robots in Landing Site Selection and Surface Investigation

Vizi P.G.^{1,2}, Bérczi, Sz.³, Horváth I.², Horváth A.F.⁴, Vizi J.Cs.³

¹MTA Wigner RCP H-1121 BUDAPEST, Konkoly Th. 29-33. vizi.pal.gabor@wigner.mta.hu; ²National University of Public Service, Hungary; ³Eötvös University, Institute of Physics, H-1117 Budapest, Pázmány Péter sétány 1/a., Hungary; ⁴Konkoly Thege Miklós Astronomical Institute, Research Centre for Astronomy and Earth Sciences, H-1121 Budapest, Konkoly Thege Miklós út 15-17., Hungary

Introduction: Nano and micro technology nowadays is the applied science of the 21st century, not only in the Earth but in space and planetary technologies, too. Smaller, cheaper and more efficient analytical methods for planetary space probes – moreover, as fleet operated - give opportunities to reach far objects in the Solar System with more developed skills than before. Nowadays technology gives wide scale of micro and nano apparatuses which can be developed and implemented into space environment. The smaller the cheaper, to send space probes into cosmos and to send far in all directions of the Solar System and beyond.

Micro and nano space probes mean in space technology to represent sizes from cubic decimeter to millimeter. Micro and nano technology means the SI originated sizes. This article uses both terminologies in their places.

NPSDR Earlier articles of authors (Vizi et al. 2012)[1] and (Vizi et al. 2013)[2] defined the concept of Nano and Pico Space Devices and Robots (NPSDR) and described the basic structures, functions, fields of the application possibilities.

In this article we describe new concepts of solutions applicable to use in Earth and planetary science, like reduced micro sized space-mothership (analogue to jet-carrier in sea) and fleet of nano probes as analytical sensor ships with wide spectrum of possible analytical sensors and with reduced smart telecommunication systems.

Fleet of NPSDRs: NPSDRs are deployable from fleet of reduced Micro Sized Space-Mothership (MSSM), sized nearly one cubic meter. Micro Sized Space-Motherships are to carry and distribute fleet of nano probes of NPSDRs. NPSDRs are with wide spectrum of possible independent or more multiplied sensors - fleet of analytical sensor ships - and with reduced smart telecommunication systems. In case of application of Micro Sized Space-Motherships for the sensor probes, for NPSDRs it is enough to communicate with motherships, which gather, pack and transmit the collected data to the Earth. Benefits of fleet of nano sized probes are: they are cheap and available abundant and redundant amount.

Power sources: Batteries for operation for long term slow consumption and for short term high energy

demand. Space qualified small battery cells for long term slow consumption operations.

In case of high energy demand for example during transmission of collected scientific data power can be earned from two component power sources, shortly like a spark.

Two components usually means one solid and one liquid component, according to pressure, mainly independently if we keep them in a closed space in a vessel, which can hold enough pressure until activating the liquid, without sublimation.

Environment friendly small probes can be contained similar elements like in meteorites according to cosmic abundance of elements. We can call them ‘meteorite-like probes’.

Analytical methods can be noninvasive and invasive. - Noninvasive method is when during measuring in first step the target can be examined only in the original state without interaction, e.g. light, mechanical spectral analyses of target, e.g. dust or gas. Noninvasive method when mechanical membranes can hit or collect dust or gas elements and can measure them with chirping vibration and can get spectral results.

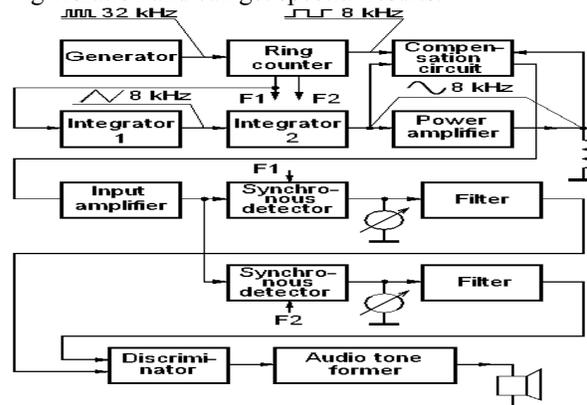


Figure 1: Schematic of a membrane spectrometer

Next step can be the invasive measuring method when a chemical reagent can be distributed or a mechanical interaction can be executed, e.g. hitting, drilling and carving.

Invasive method is to reach deeper inner regions of surfaces we can deploy long-shaped bullet like NPSDRs. It is applicable ammunition or rocket like drive in case of reaching the surface to shot itself

deeply, according to kinetic conditions. This is a forced invasive measuring, which must be well-founded and reasonable because of environmental friendly reasons which is important.

Variety of deployable analytical methods

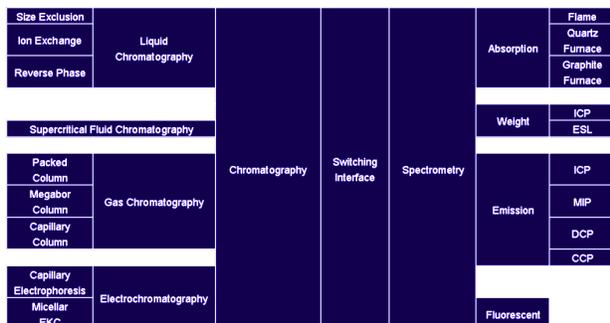


Figure 2: Chromatography and Spectrometry

Landing site selection - GIS Geographical Information Systems (GIS) useable in geoinformatics, e.g. cartography, geodesy, geographic information, photogrammetry, remote sensing, spatial analysis and deployable in planetary sciences. Spatial analysis includes a variety of techniques, many still in their early development, using different analytic approaches and applied in fields as diverse as astronomy, with its studies of the placement of planets, moons, comets and asteroids in the cosmos, i.e. in Earth and planetary sciences.

To reconstruct surface in 3D from a few available images of a distant object, to increase the well estimation of the places of interests from more viewing angles on an unknown surface. It is very important to earn good results of analytical methods to choose a perfect landing or deploying site. Below an example:

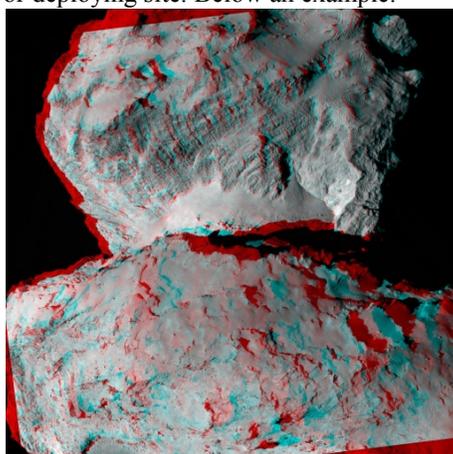


Figure 3: Comet 67P/C-G in 3D ESA

Peer over cliffs and onto the boulder-strewn 'neck' region, marvel at the layers in the exposed cliff face, and ponder the formation of the numerous crater-like depressions in this amazing 3D view of comet 67P/C-

G. Credits: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA [3]

The surface reconstructed from images gives an opportunity to estimate a better result during searching for the best landing surface.

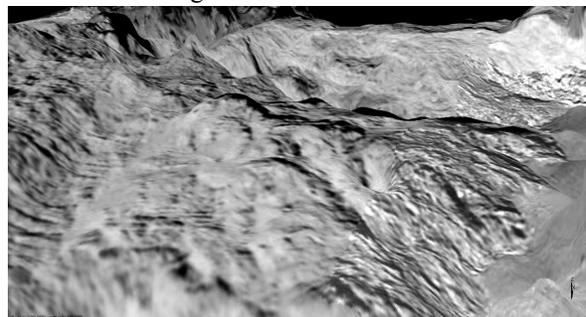


Figure 4: Processed rotated view of 'Neck Valley' of 67P (Vizi J.Cs.)

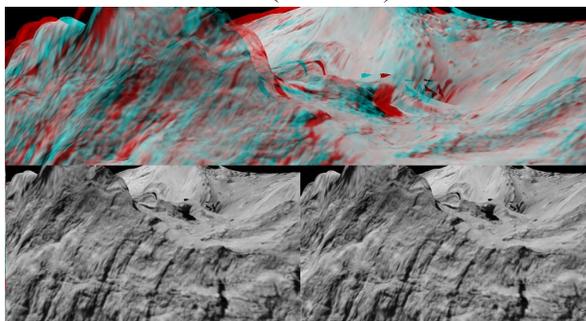


Figure 5: View of top left cliff R/B and cross eyed The full 3D video at Youtu.be/4eWdZ9jSH9k [4]

Conclusion: Technologies of last few years show it is profitable to investigate and to use available micro and nano technologies as modern analytical methods to reduce costs of researching. Moreover show how to increase the possibilities of earned data in shorter time and in bigger field of surfaces and volumes of area to be measured and discovered. Micro and nano sized space probes e.g. fleet of NPSDRs are deployable to realize and to accomplish in situ modern analytical methods in wide range of Earth and planetary sciences.

References: [References: [1] Vizi, P.; Horváth, A.; Hudoba, Gy.; Bérczi, Sz.; Sík, A. 'Lump Sugar and Salt Shaker'-Like Nano and Pico Space Devices and Robots 2012LPICo1683.1122V [2] Vizi, P. G.; Dulai, S.; Marschall, M.; Bérczi, Sz.; Horvath, A.; Hudoba, Gy.; Pocs, T.: Possible Identification Method for Martian Surface Organism by Using a New Strategy of Nano-Robots 2013LPI...44.2281V [3] Rosetta Blog ESA: Comet 67P/C-G in 3D

<http://blogs.esa.int/rosetta/2014/08/14/comet-67pc-g-in-3d/> [4] Vizi,J.Cs.:Comet 67P neck in 3D, credit ESA, Agisoft youtu.be/4eWdZ9jSH9k