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Press release

Planetary exploration: learning from bats

Bats' double frequency band bio-sonar served as an inspiration for two researchers of the University of Trento. They established a new data processing technique to improve geophysical observation based on the interpretation of bi-dimensional subsurface images acquired by means of radars. Bio-inspired radars manage to obtain more accurate information regarding the composition and structure of planets and their moons. The first tests were carried out on the subsurface of Mars. The study, which is exclusively the work of a UniTrento team, was published today in Nature Communications

Trento, 21 December 2017 – (a.s.) Nature inspires technology, that is a known fact. And yet the connections between the two can be surprising, especially when they combine very different and mysterious fields of science. A new study carried out by the University of Trento on bats and radars for planetary exploration was published today in Nature Communications. What bats and radars have in common is that they easily send and decode signals with extreme accuracy. Echolocation is an ability that bats have perfected during the evolution of their species. Their bio-sonar, a biological sonar which is also used by other mammals, like dolphins, allows them to navigate in the environment but also to locate, identify and estimate the distance from a given object.

Bats emit ultrasounds (high frequency acoustic waves inaudible to the human ear) in the environment and listen to the echo that bounces back from the different objects they find on their way. Unlike some sonars that have a limited range of action, their bio-sonar works with multiple receivers. Bat ears are slightly apart, and this makes it possible for them to pick up echoes reflected by objects at different timings and intensities, in different frequencies, based on the position of the object from which the echoes originate. Bats estimate the distance from an object by measuring the time between the sound emission and the echo from the environment. In this way, they perceive a wide range of information: on the direction of other animals, for example, but also on their size, and can even identify the type of animal. The ability to discriminate quickly between the movement of a leaf and a prey and to reduce the trajectory to get there is a precious advantage for hunting in nature. But even the most advanced artificial systems have not been able to equal these performances so far.

Lorenzo Bruzzone and Leonardo Carrer (respectively, Professor and PhD student at the Department of Information Engineering and Computer Science of the University of Trento) took inspiration from bat bio-sonars to improve the efficacy of radar systems. “Sonar acoustic waves work in a way that is similar to that of electromagnetic waves. We applied the idea of the double frequency band with echo signals to improve the accuracy of our detections in geophysical studies carried out with radars that can penetrate in the subsurface of celestial bodies in the solar system,” explained Lorenzo Bruzzone, head of the research team. “In particular, this double acquisition of data is crucial to distinguish with precision the signals coming from the surface from those coming from the subsurface of planets and their moons. The mathematical model that we have conceived adapts the mechanism used by bats to radar systems for planetary exploration, which use it to identify with accuracy the source of the reflected signals. This makes it easier to distinguish precisely between the subsurface and superficial echoes from planets. Thanks to this advancement, for example, we can better understand the geological structure of celestial bodies when we analyze data. With current elaboration systems it is very difficult for geophysicists today to interpret data, because of the many uncertainties and ambiguities due to the source of the reflected signals received.”

The study opens new scenarios for the evolution of planetary probing radars. “With this new signal processing technique - explained Bruzzone - we will be able to better use the radar data that we already have. To assess the effectiveness of this technique, we tested it for the first time when we interpreted the experimental data acquired through the observation of Mars. We were able, for example, to confirm in a simple and automatic way the results obtained in long analyses carried out by planetary scientists with land digital maps which are not always available for planets. Building on this successful approach to data interpretation we will establish guidelines to design a new generation of radar systems that can acquire even more precise information.”

You can read *“Solving for Ambiguities in radar Geophysical Exploration of Planetary Bodies by Mimicking Bats Echolocation”* by Leonardo Carrer and Lorenzo Bruzzone, which appeared in the last issue of the journal, here: http://dx.doi.org/doi:10.1038/s41467-017-02334-1

Attached is an image elaborated by the researchers (Courtesy NASA/JPL)