JPL scientists predict future space probes will have artificial intelligence to operate autonomously

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(Phys.org)—A pair of space scientists working at NASA's Jet Propulsion Laboratory at the California Institute of Technology has written a Focus piece for the journal *Science Robotics*. Steve Chien and Kiri Wagstaff suggest that future space probes will be given enough intelligence to carry out much of their mission without prompts from people back on Earth.

Despite recent successes, such as placing roving robots on Mars and sending craft to Venus, Saturn and other parts of the solar system, space scientists all agree that space science is still difficult. It is not easy to design a craft capable of venturing out to distant points in space and have them work as designed. All manner of difficulties must be imagined and measures taken to account for them. In the future, Chien and Wegstff suggest, things are only going to get more difficult as scientists send craft farther into space. Doing so, they suggest, will require more probes, which means they will have to be a lot smarter—in many situations, they may have to carry out their entire mission without intervention from humans back on Earth. They will have to be able to learn, too, so that they can change how they go about their activities. This, the pair notes, means that they will have to be equipped with advanced artificial intelligence systems that are capable of understanding requirements and carrying out activities autonomously that will serve to achieve desired goals.

Such systems, for example, will need to be able to identify situations like the difference between normal planetary conditions and a storm that has arisen. Or they might need to be able to recognize changes in season, the difference between snow and ice, or when water is moving. They will

need to be able to use their tools to look at their surroundings and to choose the best parts to study, and perhaps use what they find to conduct further studies.

Adding intelligence to robotic probes, the researchers suggest, could enable probes sent to places as far away as Alpha Centauri, which would take so long that the generation of scientists receiving the data will succeed the generation that launched the mission. Because of that, the probe will need to know how to do everything itself.

More information: Robotic space exploration agents, *Science Robotics* (2017). robotics.sciencemag.org/lookup … /scirobotics.aan4831

Abstract
Limitations on interplanetary communications create operations latencies and slow progress in planetary surface missions, with particular challenges to narrow–field-of-view science instruments requiring precise targeting. The AEGIS (Autonomous Exploration for Gathering Increased Science) autonomous targeting system has been in routine use on NASA's Curiosity Mars rover since May 2016, selecting targets for the ChemCam remote geochemical spectrometer instrument. AEGIS operates in two modes; in autonomous target selection, it identifies geological targets in images from the rover's navigation cameras, choosing for itself targets that match the parameters specified by mission scientists the most, and immediately measures them with ChemCam, without Earth in the loop. In autonomous pointing refinement, the system corrects small pointing errors on the order of a few milliradians in observations targeted by operators on Earth, allowing very small features to be observed reliably on the first attempt. AEGIS consistently recognizes and selects the geological materials requested of it, parsing and interpreting geological scenes in tens to hundreds of seconds with very limited computing resources. Performance in autonomously selecting the most desired target material over the last 2.5

kilometers of driving into previously unexplored terrain exceeds 93% (where ~24% is expected without intelligent targeting), and all observations resulted in a successful geochemical observation. The system has substantially reduced lost time on the mission and markedly increased the pace of data collection with ChemCam. AEGIS autonomy has rapidly been adopted as an exploration tool by the mission scientists and has influenced their strategy for exploring the rover's environment.