Walking robots could aid research on other planets

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A “legged” robot navigating a planetary-analog landscape in White Sands Dune Field in New Mexico. Credit: Ryan Ewing

Today NASA uses wheeled rovers to navigate the surface of Mars and conduct planetary science, but research involving Texas A&M

University scientists will test the feasibility of new surface-exploration technology: walking robots.

Ryan Ewing, Robert R. Berg Professor in the Department of Geology and Geophysics at Texas A&M, and Marion Nachon, associate research scientist in geology and geophysics, are co-investigators on the project supported by NASA and led by Feifei Qian, a WiSE Gabilan Assistant Professor at the University of Southern California Viterbi School of Engineering. The aim of the research is to create and test walking, or "legged," robots that could more easily glide through icy surfaces, crusted sand and other difficult-to-navigate environments, thus significantly enhancing scientists' abilities to gather information from planetary bodies.

While the Mars Exploration Rovers and other robots have been successfully sent into space, they typically operate based on pre-programmed agendas that require human scientists and engineers to input detailed instructions regarding where to go and what to do prior to the robots' arrival at the planet. As a result, when the robot encounters unexpected scenarios or discovers interesting measurements, it has limited capabilities to adapt its plan. This can hinder how robots and rovers navigate new environments or even cause them to miss scientific opportunities.

Ewing says enhanced understanding of how to integrate robotics technology with both planetary science and cognitive science will improve robot-aided exploration of planetary environments. This project aims to test next-generation, high-mobility robots that can agilely move through planetary surfaces and flexibly support scientific exploration goals.

"We will conduct this research in two key planetary analog sites that present well-defined gradients in soil types from crusty sand at White

Sands Dune Field, N. M., to icy rock mixtures at Mt. Hood, Ore.," Ewing explained. "Our objective is to integrate high-mobility legged robots with embedded terrain-sensing technologies and cognitive human decision models to study the geotechnical properties of these soils."

The project employs "bio-inspired" robots with legs, meaning their form is modeled after animals' unique abilities to move well on challenging surfaces like soft sand. Utilizing the latest "direct-drive" actuator technology, these robots can "feel" the terrain (e.g., sand softness and rock shapes) through their legs. This ability allows the legged robots to interact with the environment in the same manner as animals, adjusting their movement as needed.

As Qian puts it, these robots are modeled in a manner that allows them "to not just mimic how the animals look, but really understand what makes these animals successful on different terrains."

The ability to "feel" the terrain using legs also allows these robots to easily gather information about the environment as they move around and adjust exploration strategies based on this information.

"We'll be working to determine how the friction and erodibility of different soils is affected by surface crusts, rock-covered soils and ice content," Ewing explained. "We will deploy the direct-drive legged robots to map soil strength at two sites that are like landscapes on the Moon, Mars and other worlds. We will simultaneously measure environmental parameters that control soil strength, including particle size and shape, soil moisture, chemical composition and ice content."

As scientists continue to aspire to explore planetary environments, Qian notes the advantages of sending robots and rovers on initial missions to gather information before sending humans are significant.

"Even for environments where it's safe to send astronauts, mobile robots can integrate scientific instrumentation and help take precise measurements while moving around," Qian said.

The research group also includes scientists from the University of Pennsylvania, Georgia Institute of Technology and NASA's Johnson Space Center.

"This is the dream team and a very rare chance to bring a team with all the components into one project," Qian said.

Provided by Texas A&M University