Researchers developing tomorrow's space technology

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Ty'Dria Wright White, treasurer of the UA chapter of NSBE, explains features of a robotic rover to homecoming visitors. Credit: Daniel Stolte/UANews

"Dr. Fink! It won't stop doing doughnuts!"

Ty'Dria Wright White, a junior in engineering management and chemical engineering in the University of Arizona College of Engineering, repeatedly taps on the screen of an iPod, trying to regain control over what looks like a miniature tank without a turret, which is spinning on the pavement in front of her.

"No problem, just press the red button on the bottom!" Wolfgang Fink shouts back, briefly interrupting his work on another, look-alike contraption.

"We just started working with Dr. Fink, and we're still learning how to control these robots," Wright White says with a grin after regaining control of the rover, which essentially is a black, coffee-table-size box whirring back and forth on caterpillar tracks. "It's a bit challenging to learn to steer it, depending on how it faces you."

Fink, an associate professor in the college's Department of Electrical and Computer Engineering, has brought four robotic vehicles from his Visual and Autonomous Exploration Systems Research lab to the UA Mall, providing homecoming crowds with a glimpse into a future when robotic probes explore planets and moons far from Earth all by themselves.

"This robot is a prototype for a rover that could one day be exploring Mars," says Wright White, treasurer of the UA chapter of NSBE, the National Society of Black Engineers, who along with several other members is helping Fink showcase the rovers.

Because of his expertise in robotic space exploration and computer-optimized design—and his reputation for being a highly engaging professor—student members of the UA chapter had asked Fink for mentorship on a robotics project for an NSBE competition. The UA team won, and Fink now serves as the 2014-15 faculty adviser for the local chapter.

Fink and his team use the rovers as test beds for what someday could become NASA's next generation of planetary exploration tools. While the prototypes still depend on human commands sent over a wireless connection between an iPod and the rover, "the goal is to make this

completely independent of human control," Fink says.

Equipped with sensors, a computer, batteries and motors, the rovers navigate around onlookers, back off from obstacles and climb curbs and inclines. The technology could one day be used in autonomous exploration scenarios on other planets or hazardous environments on Earth where humans cannot—or do not want to—go.

"It's not the rover per se that we are after," Fink said. "This rover is considered a proof of concept. We are interested in creating a platform where we have command and control of every aspect of it, especially the computers and sensors aboard."

To that end, Fink and his group have developed algorithms that help the rover function autonomously, without human interference, and make decisions based on environmental anomalies and obstacles.

"To be able to explore terrain and territory on other planets," he said, "you have to make the system mostly autonomous, so it can keep the images and information it gathers on board, process the data and report back when it finds something very exciting."

The team currently is working on algorithms that would endow the rovers with the ability to identify interesting scientific targets—for example, unusual rock formations on Mars—all by themselves, without human programming. In other words, the rovers would be endowed with their own sense of curiosity.

"We want the rover to be able to make its own decisions, recognize its surroundings and decide which areas are interesting places to go to for further exploration," Fink said.

Many obstacles have to be cleared before such robotic explorers could

be sent on a mission far away from Earth.

A rover scaling a boulder bigger than itself. Credit: Wolfgang Fink

"They need self-preserving algorithms," Fink said. "All it takes is one careless move, an obstacle that flips the rover on its back, and the mission is over."

Equipped with a camera and LIDAR, a sensor that uses a scanning laser to inform the rover about what's in front of it, the rovers are capable of following or avoiding objects they encounter. Fink demonstrates this by approaching one of the rovers. When he is about a foot away, the machine backs up.

Conversely, the laser range finder can acquire a target, keep track of it and follow it around, Fink explained, walking as the rover followed him.

One of the students demonstrated the vehicles' ruggedness by squatting on top of it. The rover marched on, seemingly oblivious to the load.

Wolfgang Fink uses an iPod with Wi-Fi capability to remotely control a rover. Alternatively, the rover can maneuver on its own using a camera and laser sensors. Credit: Daniel Stolte/UANews

"It has enough traction to scale small boulders," Fink said.

Fink's research group pursues a concept that goes far beyond rovers capable of navigating obstacles on a firm surface. Endowed with the same capabilities of balancing hazard-avoidance and curiosity, the group has designed a watercraft to explore liquid environments such as the methane lakes on the Saturn moon Titan. The concept envisions a small armada of robotic explorers on land and sea, under the oversight of robotic blimps hovering in the atmosphere.

"Equipping the rovers with cameras and LIDAR sensors is only the very first step," Fink said. "The final step will involve an overhead perspective, such as a blimp or balloon, which will look down on the ground and identify areas of interest and obstacles autonomously,

without the aid of humans, then command these rovers to the targets. That's the goal."

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