PISCES
Pacific International Space Center for Exploration Systems

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PISCES HAWAII

Overcoming Adversity

www.pacificspacecenter.com

PISCES Program Manager Rodrigo Romo

Hau'oli Makahiki Hou!

It is the beginning of a new year and the PISCES 'ohana wishes you all a very successful and happy 2017.

During December, we were notified that the additional funds we requested for our biennial budget were not approved. While the news did dampen our spirits, we recovered quickly. We have faced adversity in the past and we are determined to overcome all obstacles and make PISCES the success story that our legislators, board members and community want to see.

We are already working on grant proposals with some of our collaborators and partners to help us procure additional funds to advance the work we've accomplished in In-Situ Resource Utilization (ISRU) and basalt-derived materials. We are also applying for grants to advance technologies in Robotic Site Preparation and Construction, and to develop Regolith Derived Feedstock for ISRU Manufacturing.

In addition, we continue to strengthen our relationships with local groups, agencies and institutions such as the Hawai'i Island Economic Development Board, Hawai'i Technology Development Corporation, other agencies within the Department of Business, Economic Development and Tourism, universities and the Hawai'i Space Flight Lab. We are also developing partnerships with private industry members like Alaska Aerospace Corporation, Honeybee Robotics and Ontario Drive Gear to realize a prosperous future for aerospace in the State of Hawai'i.

With firm support and guidance from our board, PISCES is molding a future where projects will be less dependent on state funding and more capable of contributing to the state's economy and growth.

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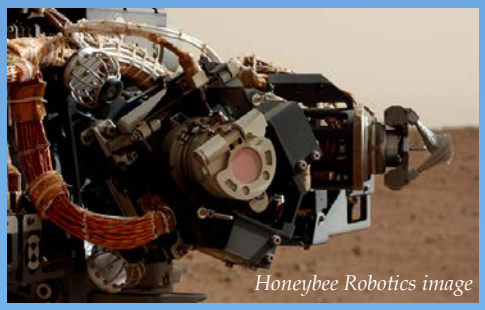
NASA image



Honeybee Robotics image

Overcoming Adversity cont…

There is a promising and bright future for aerospace in Hawai'i. Last month we had the honor and privilege of Sen. Kaiali'i Kahele's presence when he visited our headquarters in Hilo. We shared a productive "talk story" session in which we discussed PISCES' unique accomplishments in space exploration research and development over the last two years, as well as our plans for the future. We also sought ways to collaborate and contribute to Sen. Kahele's vision for aerospace in Hawai'i.

We look forward to an exciting year of advancing Hawai'i forward in 2017, researching the future of cutting edge technologies, providing education and work opportunities for youth to compete in competitive 21st century industries, and diversifying and expanding Hawai'i's economy with new industries.

On a final note, I want to extend a sincere congratulations on behalf of the entire PISCES 'ohana to two of our recurring interns, Kyla Pumehana Shetter and Colin Milovsoroff, who graduated from UH-Hilo in December with degrees in Geology. Best wishes to you both in your future endeavors!

***"Courage and perseverance have a magical talisman, before which difficulties disappear and obstacles vanish into air."* – John Quincy Adams.**

-Rodrigo Romo
PISCES Program Manager

Follow PISCES online for our latest updates, and news about the aerospace industry and space exploration!

Long-Term Economic Development

NASA Eyes Hawai'i to Support Future of Space Communication Technology

NASA images

Since its founding in 1958, NASA has solely relied on RF (radio frequency) technology to facilitate communications between spacecrafts in the heavens and bases on Earth. While RF continues to be the mainstay for space communication, rapidly advancing technologies and science instruments, as well as an increasingly crowded RF spectrum are driving the need for an alternative and superior method.

Enter laser-based communication technology. In 2013, NASA successfully proved that lasers could effectively transmit data rates 10-100 times greater than RF through space during its LADEE (Lunar Atmosphere and Dust Environment Explorer) mission to the Moon with the LLCD (Lunar Laser Communications Demonstration). Effectively, laser optical communication proved to be the evolutionary equivalent of the leap from dial-up internet to broadband. This meant that transmissions between Earth and spacecrafts could now send two-way, high-resolution data communications across space, enabling observations with unprecedented detail and accuracy.

The comprehensive satellite images we see monitoring Earth for hurricanes and other weather data are now possible for other bodies in the solar system. But first, NASA will need to build the infrastructure necessary to facilitate this new technology, including several ground stations on Earth. A network of at least three ground stations will be needed at equidistant points around the world to provide continuous communication links to space. Hawai'i's high-altitude volcanoes provide an ideal site for this endeavor.

Through comprehensive study, NASA has already identified Hawai'i's Mauna Loa volcano as one of the best sites for atmospheric clarity in the United States, offering unobstructed line-of-sight views year-round for laser transmissions to space. A few years back, the Hawai'i Legislature provided funding for two engineering assessments to determine the feasibility of putting a ground station on Mauna Loa. In mid-2016, the results of these studies, procured overseen by PISCES (a Geotechnical Reconnaissance Report and a Telecommunications Infrastructure Assessment), confirmed that Mauna Loa shows promise as a future site for ground support to facilitate laser-based space communications.

This year, NASA plans to further test laser technology communication with the Laser Communication Relay Demonstration (LCRD), which will transmit data from California to an orbiting satellite, then relay it to a site on Haleakala volcano on the island of Maui. LCRD is considered a critical step toward the next generation of satellite systems going into orbit. (*Cont. on page 3…*)

Future of Space Comm…

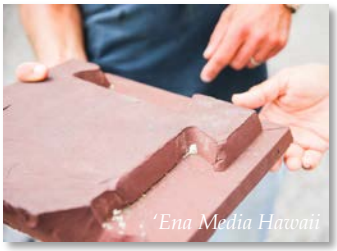
Laser technology will not only increase bandwidth capability, but also reduce power consumption and mass. RF antennae require more energy to power amplifiers due to signal spread. During the Apollo era, NASA flew antennas that were seven feet in diameter to communicate with Earth. NASA's Lunar Reconnaissance Orbiter, launched in 2009, used a considerably smaller 2.5-foot antenna. But laser terminals only need to be as small as four inches in diameter due to their focused signal concentration over long distances. Consequently, spacecrafts can be built lighter and smaller, saving precious fuel and energy. Furthermore, lasers will enable on-demand communication to aid human safety in space by providing telemedicine for astronauts.

The leap to laser communication is inevitable given advancing technologies and the expansion of space exploration – and not just for NASA. The commercial aerospace industry is moving in this direction too. Laser technology can meet the needs of missions to near-Earth space, the solar system, and potentially, interstellar travel. The State of Hawai'i can play a key role in this evolution, providing infrastructure and workforce for some of the first laser-based systems on Earth - technologies that are sure to be critical in the emerging new era of space exploration and scientific study.

To request a copy of the engineering studies conducted on Mauna Loa, please visit:
http://www.pacificspacecenter.com/nasa-laser-communication-ground-station/

Applied Research

PISCES and Honeybee Robotics Team Up for Grant Work in Planetary Robotic Construction

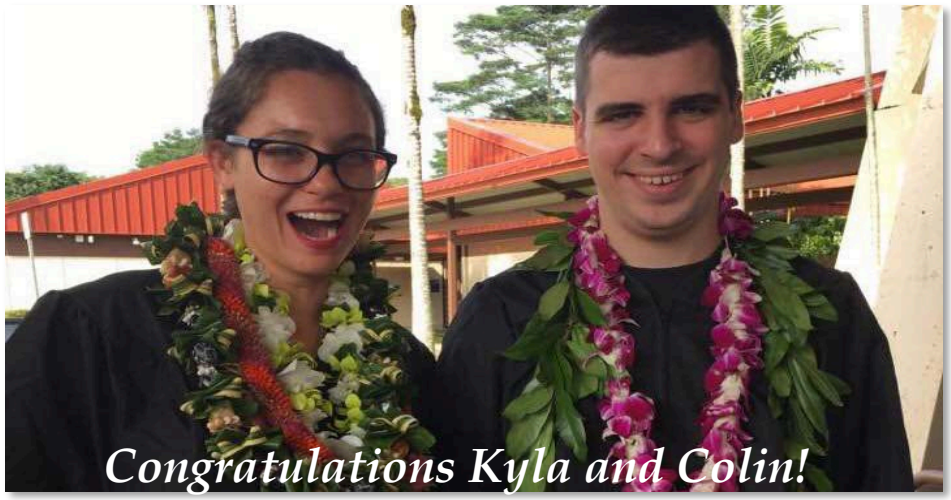


In late 2015, PISCES completed a robotically-built lunar landing pad in Hawai'i in partnership with NASA, Honeybee Robotics and the Hawai'i County Dept. of R&D. Now, PISCES is continuing the work of developing a feasible system to robotically build objects in-situ by applying for NASA's STTR (Small Business Technology Transfer) program, in partnership with Honeybee Robotics. STTR is a federal initiative providing grants and contracts to small and start-up companies to create new or enhanced products or services using advanced technology.

PISCES and Honeybee are submitting the proposal this month under the Robotic Site Preparation and Construction of NASA's grant subtopics. The Phase I proposal is eligible for up to $125K over 12 months to support the development of "planetary Lego blocks" made of volcanic basalt, which are planned to be more durable and efficient than their predecessors. The selected recipient of the STTR grant will be announced by NASA in April.

Workforce Development

Former PISCES Interns Graduate from UH-Hilo



Two former PISCES interns just celebrated the achievement of graduating from the University of Hawai'i at Hilo! Kyla Pumehana Shetter (L) and Colin Milovsoroff (R) each earned a B.S. in Geology in December.

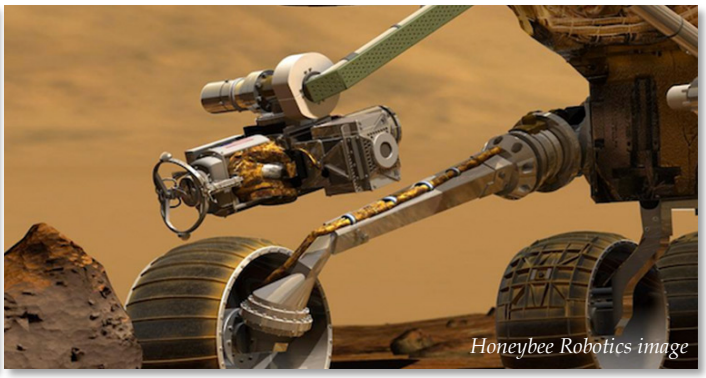
The pair have both worked with PISCES in various roles since the spring of 2014, conducting planetary analog characterization by surveying lava terrains on Hawai'i Island and identifying potential sites for environmentally-friendly testing.

The new graduates have a head start in studies and experience through their internship work, while also having contributed to NASA's BASALT (Biologic Analog Simulation Associated with Lava Terrains) Research Project in November. During this groundbreaking research, they worked with an international team of elite scientists, astronauts and mission controllers who were studying the landscape of Mauna Ulu on Hawai'i Island to better understand the habitability of Mars, in preparation for a future manned mission to the Red Planet.

PISCES GUEST SPOTLIGHT

Building Robots for the Extreme Challenges of Space

Dr. Kris Zacny, Honeybee Robotics



Dr. Kris Zacny is the VP and Director of Exploration Technology at Honeybee Robotics and leads the effort of developing cutting edge robotics for space exploration. Dr. Zacny's work focuses primarily on robotic space drilling, sample acquisition, transfer and processing technologies, as well as geotechnical systems for mining applications.

Space is the most extreme and unstructured environment imaginable. We are challenged with extreme conditions from temperature, pressure, and gravity that span orders of magnitude depending on which planetary body we are targeting. Currently, for example, we are building a sampling system for Venus - our system has to withstand 500 °C and 92 bar atmospheric pressure. We had to develop electric motors that can work at these conditions. You cannot buy motors like this anywhere on Earth. In the same room, we are building a deep drilling system for Jupiter's moon Europa. The hardware for this robot must withstand conditions of -170 °C temperature, hard vacuum, and radiation that can kill living organisms in a fraction of a second. The goal of the drill is to penetrate up to kilometers through the surface to search for signs of extinct or existing lifeforms. These challenges are what make our job so much fun - no two days at Honeybee are alike.

Most of the time we work together with scientists and in turn, our robotic systems must meet requirements imposed by the science community. For example, the Rock Abrasion Tool (RAT) on Mars Exploration Rovers - a grinder that creates 45 mm-diameter polished surfaces on a rock - was driven by a science requirement to enable analysis of a flat, pristine rock surface. It's very rewarding when our hardware enables new discoveries. In the case of the RAT, it supported scientific proof that water once flowed on the surface of Mars!

The new frontier in space robotics is In-Situ Resource Utilization, or ISRU. ISRU, or living off the land, enables the utilization of local resources to sustain exploration, whether robotic or human. The most obvious resource is water, which can be used for agriculture and/or drinking water, or electrolyzed into hydrogen and oxygen for rocket fuel. Water is actually quite an abundant resource in space. Jupiter's moon Europa, which is smaller than Earth's moon, has more water than Earth! Numerous NASA studies have confirmed that we cannot afford human exploration without ISRU. The State of Hawai'i and PISCES have been at the forefront of ISRU, and that's thanks to Hawai'i's strategic resource - volcanoes! Volcanic rocks and soils are found in all rocky bodies (Venus, Mars, and Moon etc.) and as such, by testing our hardware in Hawai'i we learn how the hardware will perform on other planets.

Recently we have been working with PISCES to develop robotic systems for landing pad construction. Imagine landing a helicopter on a beach - airborne sand will sandblast not only the helicopter itself but everything around it. The same is true when a rocket is trying to land on another planet. Rocket thrust will interact with planetary regolith and sandblast everything in its outer vicinity, as well as the rocket itself. The Mars Curiosity rover was sandblasted like this during its landing and airborne particles damaged the rover's weather station. The Curiosity rover, however, is relatively small compared to landers that will carry humans to Mars. Rockets that will need to slow the incoming descent of a spacecraft carrying astronauts onboard will be much larger and create exponentially more thrust. It is not unreasonable to expect these rocket engines to create deep craters. PISCES' work is therefore instrumental in enabling future human landings on Mars and also the Moon.