National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Manufacturing

Regolith-Polymer 3D Printing

Building infrastructure using available resources

The history of construction materials and methods has evolved over time, with Portland cement concrete being the most widely used material on Earth. Constructing habitats and infrastructure on the Moon and Mars, however, requires a different approach given the lack of such conventional construction resources and materials.

Recognizing the need for in-situ resource utilization (ISRU) to support long-duration human missions to the Moon and Mars, NASA's Kennedy Space Center and Sidus Space have developed a novel three-dimensional print head apparatus using regolith-polymer mixtures as a building material. The invention paves the way for enabling the construction of habitats and other critical infrastructure on the Moon and other planetary bodies using available resources. The Regolith-Polymer 3D Printing System can also be adapted to work with other crushed rock materials or mixtures depending on resource availability at construction sites.

BENEFITS

- Facilitates in-situ resource utilization (ISRU): The invention was designed to utilize in-situ resources, reducing the need for transporting construction materials long distances (e.g., from Earth to the Moon). Additionally, less material is needed as advanced designs can use optimized hollow structures.
- Offers automation & precision: The invention is designed to work with a robotic arm, providing precise positioning and movement during the printing process.
- Provides versatility: This 3D printing system is compatible with various regolith (or crushed rock)-polymer mixtures, enabling adaptability to different environments.
- Enables complex geometries: The invention also makes it possible to print complex shapes that cannot be achieved using concrete from work, brick laying, or other traditional construction processes.

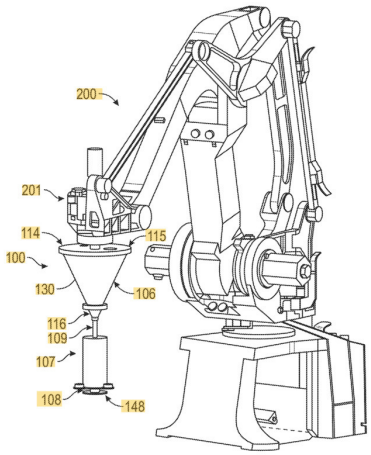
THE TECHNOLOGY

The invention consists of a 3D print head apparatus that heats and extrudes a regolith-polymer (or other) mixture as part of an additive manufacturing process. The technology includes a securing mechanism, hopper, nozzle, barrel, and heating system. The securing mechanism attaches to a wrist joint of a robotic arm. The hopper, connected to the securing mechanism, has a cavity and a lower aperture. The barrel is an elongated, hollow member with its first end connected to the hopper's lower aperture and its second end connected to the nozzle's upper aperture. The heating system is positioned along the barrel and comprises a heater, thermocouple, insulator, and heating controller. The heating controller activates the heater based on input signals received from the thermocouple.

The print head apparatus also includes a feed screw, drive shaft, and motor. The feed screw is positioned within the elongated hollow member of the barrel, and the drive shaft transmits torque to the feed screw. The motor provides torque to the drive shaft.

An agitator is secured to the drive shaft, facilitating the consistent movement and mixing of the regolith-polymer mixture in the hopper. The nozzle includes a tube with an open end and an occluded end, allowing the mixture to be extruded through the lower aperture.

The jointly developed 3D print head technology enables efficient, large-scale additive construction using in-situ resources, such as regolith or other materials. The innovation reduces the need for transporting materials from Earth and allows for sustainable habitat development on the Moon or Mars. Given its adaptability to different crushed rock-polymer materials, the invention may also serve as an alternative to conventional Portland concrete construction on Earth.



An environmental view of the patented and jointly developed 3D print head mechanism, in combination with a robotic arm (200).

APPLICATIONS

The technology has several potential applications:

- Lunar habitat and infrastructure construction: Building habitats on the Moon (or other planetary bodies) using in-situ resources.
- 3D-printing of large structures: Creating large structures on Earth, the Moon, Mars, etc.
- Expand construction materials: Leverage available materials to build infrastructure on Earth and beyond.

PUBLICATIONS

Patent No: 11,260,589

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More Information

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