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BIO-MIMICRY: A POSSIBLE NATURAL SOLUTION TO DESIGN SUSTAINABLE HABITAT ON MARS

Abstract

Nature has always been inspiring to human since the beginning of civilization. Enforced by the natural disasters and extreme weather; the interest of building shelters for protection has been intrigued with our journey from the caves towards building sustainable home. Humanity is ushered one step ahead with a plan to build sustainable architecture on Mars but the extreme environments i.e. radiation natural disasters would be the biggest challenges to survive on Mars. The purpose of this investigation is to find possible solution by decrypting the technical information encoded and preserved in the nature. Inspired by some naturally developed structures i.e. Turtle shell, shell of armadillo and giant clam, the approach is to mimic the naturally grown structures by replicating them with the help of 3D printing techniques. The main objective is to investigate 3D printing capabilities to design and develop sustainable habitat on mars utilizing ingenious materials. In this method, a novel synthesis and processing technique has been applied to convert the coarse Mars regolith simulant or powder into fine dust particles (less than 25 μm). The processed solid content is mixed with dispersant and water to optimize and develop mars regolith ink. The processed ink is utilized by a customized 3D printer to fabricate complex three dimensional structures from CAD data. Various nozzle sizes are used (250 μm – 1.5 cm) to develop 3D printing parameters that can compensate into retaining the shape and size of the 3D printed structures. The different components of an entire shell structure are individually 3D printed then assembled to develop a final structure. The structural integrity have been estimated by geometrical shape optimization. The strength varied with different types of shells and their internal structures. A slow printing rate (5-10 mm/second) has delivered better layer deposition and approximately 60% green density. All three different types of shell structures have been investigated. Various internal microstructure and patterns i.e. hexagon, oval and curved shapes are also 3D printed to understand the potential of such techniques to fabricate complex shapes. Further analysis is required to estimate the shrinkage rate of fully printed structure, their structural integrity, toughness and rigidity.