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TOWARDS A NOVEL BIO-INSPIRED TECHNOLOGY FOR ACCESS TO THE PLANETARY SUBSURFACE

Abstract

In the exploration of extraterrestrial planets and bodies, and the search for life it's believed that many of the markers will exist below the surface. This requires access to the subsurface for sampling and experimentation. Dual-Reciprocating-Drilling (DRD) is a new biologically inspired technology based on a wood wasp ovipositor which burrows deep into wood to lay eggs. The DRD penetrator module is scalable and consists of two backward facing teethed halves that reciprocate in opposition to one another generating a drilling force that reduces the required force for penetration. This has the potential to improve the efficiency of the drilling system. The teethed elements are easily changeable to maximise the DRD efficiency in the target substrates.

The reciprocating motion consists of two phases. During the first phase the first half of the drill head retracts away from the regolith while the other drives down into the regolith displacing the material around its teethed area. Once the first drill head is fully extended the cycle moves into the second phase repeating the reciprocating motion with the other drill head. It is the effects of this reciprocating motion on the surrounding regolith that reduces the forces required to achieve penetration.

Funding from ESA has seen the design, development and testing of a proof of concept model to evaluate the concepts of DRD. From these experiments the system has evolved to a more advanced architecture that includes the drive mechanism miniaturised and integrated into the heads of the drill, as well as further development of modularly adjustable bays within the penetrator for scientific instrumentation. A compact deployment system that stabilises the bore-hole and provides an overhead force on the penetrator module is also under development (in classical drilling this can be compared to the weight-on-bit).

This paper presents the current state of the DRD penetrator, discusses the evolution of the penetrator and the designof the integrated mechanism within the drill heads. It also presents an overview of the deployment mechanism, the experimental configuration (including sample regolith preparation) and demonstrates the performance of this new technology through experimentation.