SUNFISH®: A human-portable exploration AUV for astrobiology investigations in complex 3D environments

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Introduction: Stone Aerospace is developing the SUNFISH® autonomous underwater vehicle (AUV) which addresses many of the challenges of remote, autonomous exploration in unstructured environments such as the Ocean Worlds of the outer Solar System. The AUV was designed to be a highly-capable platform for operating in a wide variety of complex 3D spaces, ranging from man-made (e.g. piers) to natural (e.g. reefs, caves, and under ice).

The descendant of larger AUVs developed at Stone Aerospace (e.g. the NASA-funded DEPTHX, ENDURANCE, and ARTEMIS vehicles), SUNFISH is miniaturized, person-portable, six-degree-of-freedom (6-DOF) hovering vehicle with built-in precision navigation and control, multibeam sonar mapping, imaging, and conductivity/temperature/depth (CTD) capabilities. It was designed to be a highly-capable platform for operating in a wide variety of complex 3D spaces, ranging from man-made (e.g. piers) to natural (e.g. reefs, caves, and under ice). Building on these base functionalities, we have developed high-level capabilities for performing simultaneous localization and mapping (SLAM), exploration, path planning, and precision return home and docking. We describe these capabilities, and present a demonstration in the unstructured labyrinthine 3D environment of Peacock Springs in Florida, USA. SUNFISH demonstrated the capability to autonomously explore this environment, creating a real-time map with which it navigated through the cave. SUNFISH penetrated 120 m into the cave system and was able to autonomously navigate back to the deployment location. The meshed surface produced from the sonar data acquired during transit through this section of the springs represents the highest-resolution and first full 3D map of this otherwise well-explored hydrological feature.

SUNFISH and its technologies have direct application in several astrobiology-relevant goals, including furthering exploration and life search strategies for Ocean Worlds, as well as enabling Earth-analog fieldwork in structurally complex, remote aqueous environments such as caves, under ice shelves, or in sub-glacial lakes.