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FISHER-X: A BIOINSPIRED ROBOTIC ALTERNATIVE FOR THE EXPLORATION OF THE OCEANIC ENVIRONMENT ON A JUPITER'S MOON

Abstract

The search for life outside the Earth is one of the most significant challenges for humanity and has raised critical questions in science and philosophy since its origins. Thus, life has been primarily related to the occurrence of liquid water as a keystone for habitability. Europa Clipper will orbit the Jovian moon Europa in the following years to confirm liquid water signs far from the Earth below the crust of another planetary body, paving the way for a future flagship mission be able to penetrate the icy sheet and collect liquid samples in situ. The paper presents the design of FISHER-X, an acronym for "Fin-Propelled in Situ Habitability Exploration Robot," a soft robot bioinspired by the anatomy of the liparid fish: *Pseudoliparis swirei*, a hadal vertebrate species recorded as inhabiting the most extreme depths of the Earth's ocean. This robot would be ideal for an astrobiological mission in an alien ocean. The probe will travel from Earth to Europa onboard a spacecraft in our mission scenario. In Europa's orbit, a lander would be sent to the surface with a cryobot and the probe inside. Then, the cryobot would drill the ice crust and travel through the crust to the ice-water interface, transporting the robot protected by a capsule, like an elevator. FISHER-X will be released in the liquid region to record the physicochemical conditions, search for biosignatures, sample the water column, and deliver information to the lander on the surface.

The robot movement capacity and natural swim would adapt to an unknown environment reducing the disturbances that would alter the natural conditions.Moreover, the polymer material selected would allow the probe to withstand the ocean's temperature, pressure, and conductivity. The authors summarize the high-level requirements for exploring the water-ice interface, FISHER-X's mechanical technology, electronic and communication challenges, propulsion-stabilization system, simulation of movement, and selection of materials to withstand the environmental conditions of the ocean. The basic mechanical design was modeled using Autodesk Fusion 360, estimating its resistance with different materials under extreme pressure conditions, and the robot movement was also simulated using Matlab. The conceptual operations and payload instrument candidates based on marine research instruments are also detailed. This research has been developed since 2021, by an interdisciplinary team of Peruvian professionals, with the hope to enroll Latin American designs in future space exploration plans.