A System of Mesoscale Biomimetic Roboswimmers for Exploration and Search of Life on Europa

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Physical Sciences Inc (PSI) in collaboration with the Jet Propulsion Laboratory (JPL) and the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) propose a revolutionary approach for the exploration of oceans and the search for marine ecosystems on the Jovian moon Europa. Our concept involves numerous small (~10 cm scale), autonomous, robotic swimmers which as individuals and as a cooperative group sense the ice, ocean, and sea floor environment and measure the physicochemical properties characterizing the presence of life. The design of these roboswimmers is biology-inspired., i.e., they are inherently weight and power efficient and compatible with the ocean environment at great depths. Using technologies anticipated to be available two to three decades from now, the robots will incorporate microminiaturized optical and tactile sensors, acoustic communication , microactuators for locomotion, ultrafast processors, and knowledge-based/synthetic intelligence for control and for individual and collaborative decision making. Our approach of using a large number of small, intelligent robots will allow the exploration of large areas with much lower power expenditures than a single, large hydrobot.

An ocean under a thick layer of ice on Europa has been indicated by missions to the Jovian system by the Galileo spacecraft in the late 1990's and by the Voyager spacecraft in the late 1970's. The intense tidal forces exerted by Jupiter on Europa's interior are thought to result in volcanic activity, producing hot hydrothermal vents on the ocean floor. These observations and hypotheses have led to the speculation that chemosynthesis-driven primitive ecosystems might exist within Europa's ocean. If true, this would be one of the greatest discoveries for mankind; existence of life on another planet within our solar system. In Phase I and a follow-on Phase II, we propose to develop the system architectures and infrastructures, and identify the technologies necessary and create a roadmap to reach this goal.